AGRICULTURAL ENGINEERING

Published by the AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Headquarters of the Society: Saint Joseph, Michigan

RALPH U. BLASINGAME, *President* RAYMOND OLNEY, *Secretary-Treasurer*

VOLUME 17 DECEMBER 1936 NUMBER 12

CONTENTS

Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the headquarters of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cents a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .

AGRICULTURAL ENGINEERING

VOL 17, NO 12 EDITORIALS DECEMBER 1936

Social Responsibility of Engineering

AN OPEN letter from President Roosevelt to the heads of more than one hundred engineering schools raises the question as to whether engineering students are being taught, among other things, "the social responsibility of engineering." He cites, for example, engineering concentration on great dams, etc., to the neglect of water control at the numerous headwaters of large streams.

He suggests a thorough exploration of the social responsibility idea. It is now the engineers' move. We present some considerations for what they may be worth.

As a specially trained group, engineers unquestionably owe the public the benefit of their insight into physical causes, effects, dangers, possible remedies, preventative measures, and opportunities relating to public welfare.

As a minority group, engineers can present the facts as they see them. They can not force action or public support for work they see as needed in the public interest. The extent of their moral responsibility for persuading social groups to act on the facts as presented, and the manner in which this persuasion might best be accomplished, are unsettled questions. They have established American Engineering Council as a means of presenting the facts and exercising a measure of persuasion.

Engineering activity is more strongly motivated by economic forces than by theoretical ideals. In the case of most engineers, their profession must earn them a living. They necessarily apply their technology where it finds strongest support and encouragement. It is not the spectacular appeal of great dams, bridges, and industrial plants that leads engineers to build them. Nor is it because they have been taught to direct their attention only to big things. It is direct demand, backed by ability and willingness to pay for services which offer the prospect of being worth their cost many times over, by minimizing and insuring investment, assuring accomplishment of definite physical purposes, and increasing the probable profitable return on the investment.

The application of engineering to jobs which could not be done without it; to large projects under centralized control, where its value was most easily apparent, its cost most easily absorbed, and its employment most easily negotiated, was a natural early stage in the development of the profession.

A natural further development, already in progress, is the application of engineering to small physical units under highly diversified control; to jobs already being done after a fashion without benefit of engineering; and to work in the interest of the public, as such interest becomes apparent to governmental majorities or cooperative groups with power to support the needed engineering work.

The cost of working out all the engineering details involved in a small project may be almost as great as for a large project, and may easily be prohibitive. It can only be kept from being prohibitive by engineers applying their efforts primarily, not to the individual small project, but to getting basic facts and developing principles, methods, and equipment for application to various common combinations of conditions and requirements.

For example, agricultural engineering is characteristically the engineering of small projects under independent control; of an industry that existed before the engineering profession was born; and of exhaustible natural resources which are distinctly of public interest.

Only large farms can support the full-time services of an agricultural engineer, or offer large enough projects to warrant employment of private consulting engineering services. And where these services are so employed, they are backed by the foundation of specialized agricultural engineering dvelopment of the past thirty years in applying engineering to the predominating number of smaller farms.

This development has been made possible by gradually growing public and industrial support. Agricultural engineers have been employed in growing numbers by the U. S. Department of Agriculture and other federal agencies, the land-grant colleges and experiment stations, and manufacturers of engineered equipment and materials specially designed for farm use. Their activity has included fundamental research, development and application study, extension work among farmers, and the training of young agricultural engineers.

Improved methods and equipment have been made available to farmers. Facts of public interest have been learned and reported, and recommendations made. The cost of this engineering has been distributed among taxpayers and users so widely as not to be prohibitive or excessive at any point.

But agricultural engineers, and other engineers for work on small projects of large aggregate importance and public interest, were not employed soon enough, in large enough numbers, or with sufficient prestige and support to more than begin to meet the need. Nor were their recommendations taken seriously enough, or carried out thoroughly enough, to avoid conditions which it is easy to look back on, to deplore, and to charge to shortsightedness and neglect on the part of the engineering profession!

The social responsibility of engineering is, in many respects, an advanced concept, and one which has been popularized by recent economic depression. Engineers accept, as a matter of course, full responsibility for the physical performance and safety of works built according to their plans and specifications. There have been instances of miscalculations and failures, but in general the engineering way of planning and doing has become recognized as the safest way.

When and to the extent that the public wants to follow, trust, and support engineering leadership and recommendations on the social safety, feasibility, and direction of engineering progress, engineers will undoubtedly respond with research and recommendations on such matters.

The growing realization of the interdependence of social and economic welfare points to progress in this direction as a matter of enlightened self-interest on the part of economic organizations with the power to employ engineering services, and the confidence to follow their recommendations.

Support for engineering attention to social values may

be expected to result in such attention, both in engineering practice and engineering education. Meanwhile, the engineering schools, in attempting to develop good technical engineers who are also good citizens with adequate appreciation of social values, have a responsibility to avoid developing engineering philosophers primarily concerned with social theories which for lack of organized demand and financial support, have no possibility of early application.

Social problems are more complex and less tangible than physical problems. They are not a subject for spare-time tinkering. When and to the extent that engineers in public and private employment are hired and paid to study and make recommendations on social values, consequences, and problems of engineering progress, and their recommendations are given a fair trial, their technical capacity or incapacity in this field will become evident. Engineering educators will then have some concrete cases on which to base consideration of the merits of their curricula on this point.

A Question for Animal Power Advocates

AN INTERESTING angle and a legitimate question in the animal versus mechanical power argument is raised by L. J. Fletcher. We quote:

"I am particularly sensitive to a statement so frequently made, (that) mechanized farm power has destroyed the market for the products of 35,000,000 acres. People making this statement fail to realize that the average reader has no way of knowing that the labor employed to produce this mechanized farm power, and to produce the services, such as fuel, oil, and parts to keep it going, quite entirely makes up for the loss of the 35,000,000 acres.

"Each inhabitant of the United States consumes the product of two acres; a horse consumes the product of about 3½ acres. In other words, if 17,500,000 people secure their sustenance from the industries and employment created by the displacement of 10,000,000 horses, the farmer is just even with the boards. If a fair share of the automobile and truck business were put in with the tractor, it is easy to show that more than 17,000,000 people secure their livelihood from the automotive and farm power industries which displaced the horse."

The question for animal power advocates to answer, then, is what have they to offer these 17,000,000 people who would be displaced by a return to animal power on farms in the United States? And what reason have they to offer farmers in justification of feeding horses instead of men?

Could other industries readily absorb 17,500,000 men without glutting the labor or commodity markets? Could they be relegated to farming, for which they are poorly equipped by experience, temperament, and initial capital? Or is the life of a horse justified over and above the life of a human being? Of course we are only asking, but the latter seems as likely to be true as either of the former; and if men are to be subjugated to horses, for the sake of argument, let us pursue the philosophy to its logical conclusion, a nation of horses, with the more prosperous possibly indulging in keeping a man, or a stable of men, to do work and provide amusement!

The importance of the argument lies, not in its merit as an argument, but in the fact that the above and other angles on the mechanical power side have not yet been adequately presented to the general public, whose opinions support or deter engineering and human progress.

Agricultural Engineering Expands

A SIGN of the times is increased interest in agricultural engineering and what it can do, on the part of specialty branches of agriculture and of all business interested in farmers either as producers or consumers.

Engineering was logically first applied in agriculture to general farming. As the study has continued, as principles have been developed, as technique and equipment have been perfected, they have found application in new and more specialized fields.

Dairying and poultry production, as elements of general farming, were among the first specialties to receive agricultural engineering attention.

Engineering progress in row-crop equipment, in spray equipment, and in the handling and storage of perishable products have made it a factor in the fruit, market gardening, and nursery industries. Electrification introduced it to greenhouse and floral culture.

Cotton and sugar beet producers have appealed to agricultural engineers for help in solving their labor peak problems.

The country awoke to its soil and water conservation problems, to find they involved considerable engineering, and to find agricultural engineering veterans in the field needing only the support of public opinion to make their technical leadership effective.

The crops new to North America, soybeans, Jerusalem artichokes, tung nuts, and pyrethrum, find agricultural engineers openminded and objectively interested in methods and equipment for their economical production.

Organic chemistry in industry looks out on agriculture as a rich potential source of additional raw materials. At the critical point of unit cost, it meets agricultural engineering, interested in the economics of lowering farm production costs rather than in artificially supported farm prices.

The metal, petroleum, and building materials industries looking toward new markets, see agriculture, and investigating, find agricultural engineering a means to sound market development, recognizing that continued use of these products by the farmer must be profitable to him as well as to the sources of supply. Agricultural engineers show the industries and the farmers the way, and the limitations beyond which products cannot be "pushed" by sales forces, or bought by farmers, with success.

Likewise the farm as a market for services, from building insurance to electricity, is found to depend on its construction and equipment set-up.

Agricultural engineering is technically better set than ever to render real service both to agriculture and to the related industries. Conscientious preparation within this branch of engineering, and increasing understanding and appreciation of its field and abilities on the part of those it can directly serve, presage for agricultural engineering the beginning of a rapid, and, we hope, sound professional growth.

Engineering Frontiers in Agriculture

By L. F. Livingston

ENGINEERING frontiers in agriculture means this: What is the most important problem at this time for the agricultural engineering profession to solve in order that it may fulfill its function and bring engineering principles into every phase of farming?

The agricultural engineer knows that the mechanization of farming has to a large extent made impractical the old pattern of field layouts. Yet, thousands of farmers are still turning their furrows in the same direction and within the same limits taken by their grandfathers decades ago, when plows were all single bottom and the topsoil had not been washed unchecked from millions of sloping acres.

The agricultural engineer knows that a delicate balance must be maintained between the size of the farm, the type of farming, and the number of resident workers available. Yet relatively few farms do maintain this balance, and most of those through good luck rather than good engineering.

The agricultural engineer knows that the farmer, in order to keep only that livestock which more than pays for its board and keep, to raise only those crops which show a clear profit, must keep complete records of all business transactions, and must analyze them with an intelligent and open mind. Yet, there are few barns or poultry houses which do not harbor unsuspected "boarders."

The agricultural engineer knows—everyone knows—that farm machinery, just as much as industrial machinery, must be protected from rain and snow, sun and wind, else it will deteriorate. Yet every farming community has its sad quota of plows, cultivators, harrows, even tractors, left unprotected from the weather when not in use, in many cases gathering rust and old age through the winter.

The agricultural engineer knows these things, and as time goes on he will know still more. But does the farmer know them? In an incredible number of cases he does not. And, in still more instances, he has been given the information, and has remained unconvinced, or has not known just how to go about making the changes that might make the difference between success and failure on his farm.

Some of you may say I am talking about agriculture, not engineering. I say to you that there is engineering in every phase of agriculture. Agricultural engineering is a cooperative profession. It is different from any other branch of engineering in that the agricultural engineer has a multitude of specifications given to him to work from. In buildings, he cooperates with the dairyman, the poultryman, the livestock breeder, the grain grower. In drainage and irrigation, it is with the soil and agronomy experts, and in farm machinery, those with whom the agricultural engineer must cooperate are too numerous to mention.

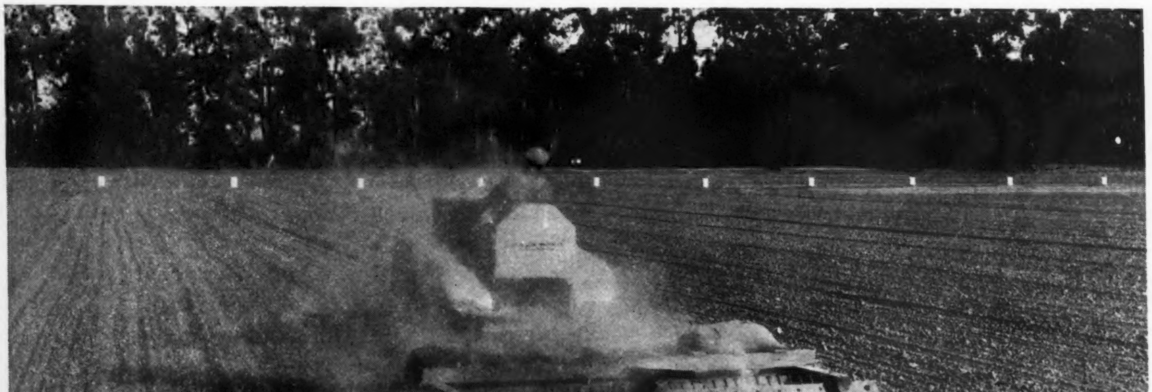
Too often in the past the agricultural engineer has shut himself out because he was afraid of losing face by being a cooperator and many times a secondary leader in some most worthy piece of work, the success of which depended upon the application of engineering principles.

The responsibility facing the agricultural engineer, the *foremost frontier* which we as a profession have approached and must conquer, is to reach every farmer on his own farm with all the sound agricultural engineering information now available. Our job is to convince him that his salvation lies in applying known and proven engineering practices on his farm and to show him how to solve his own individual difficulties in the quickest, easiest, and most economical way.

At best, farming is a gamble. Rain and sun, so essen-

An address before the North Atlantic Section of the American Society of Agricultural Engineers at Skytop, Pa., October 15, 1936.

Author: Manager, agricultural extension section, E. I. du Pont de Nemours & Company. Mem. ASAE.



TO PLACE THE MEANS OF CONTROLLING CONDITIONS IN THE HANDS OF EVERY FARMER, TO CONVINCE HIM OF THEIR VALUE, AND TO TEACH HIM HOW TO USE THEM IS THE JOB OF EVERY PERSON INTERESTED IN THE FUTURE OF AGRICULTURE

tial in moderation, can also destroy, and no man can control the balance in which they are given to the world. But man can, and does, control the wastes in materials, operation and equipment, the menace of plant diseases, and the onslaught of insects. And man can, and does, materially increase the quality and quantity of crop yield. To place the means of controlling these controllable things in the hands of every farmer, to convince him of their value and to teach him how to use them is the job of every person interested in the future of agriculture. Again, I repeat that there is engineering in every phase of agriculture.

This foremost frontier is a job for the supereducator, the supersalesman of progress. It is a challenge to every engineer who has the future of agriculture at heart, and must be approached with patience, persistence, and infinite tact.

A BROAD OUTLOOK ON THE JOB OF AGRICULTURAL EXTENSION

President Glenn Frank of the University of Wisconsin has said: "The future of America is in the hands of two men, the investigator and the interpreter. We shall never lack for the administrator, the third man needed to complete this trinity of social servants. We have an ample supply of investigators, but there is a shortage of readable and responsible interpreters, men who can effectively play mediator between specialists and laymen. The practical value of any social invention or material discovery depends upon its being adequately interpreted to the masses."

What President Frank has said applies to the agricultural engineer today as never before. I have repeatedly stated my position regarding research. Its importance cannot be overestimated. Records of the past few years are littered with examples of disastrous projects undertaken without sound research to back them up. Research in agriculture is going ahead with its thousands of projects all over the country. Some of these include agricultural engineering; all of them should. Today, the need is for the man who can and who will interpret the results of that research in terms that the people of the country will understand and will use.

Not so many years ago there were only three state agricultural extension departments with specialists in agricultural engineering. Today thirty-seven states have eighty-four specialists doing part or full time work in agricultural engineering—and each man trying to do three men's work. Many industries have extension men who are doing strictly agricultural engineering extension work in their particular field.

THE PLACE OF AGRICULTURAL ENGINEERING IN AGRICULTURAL EXTENSION

What is now being done by the industrial extension men of the electric power companies and the electrical appliance companies cannot, in my estimation, be praised too highly. All of you know that building a rural power line is only the start. The success of that line depends on the current used, and the success of the farmer using that power depends to a large extent upon how soundly the rural electrification specialist, whether college or industrial, educates him in what he can and cannot do with electricity on his own farm.

Somehow, extension work in agricultural engineering which should be foremost in agriculture, has fallen behind the other groups, and we, as a society, have been only moderately diligent in selling what we know to be sound, worth while and financially valuable to the farmer himself. Our greatest frontier is to overcome this. It is necessary that we bring before everybody in the country the fact that we can be of more financial service to the farmer than any other group dealing with agriculture, that every farm which is surveyed from an engineering angle can be financially bettered, and usually within the means of the owner.

One of our country's foremost county agricultural agents recently told me that sooner or later there must be an agricultural engineer in every county in the United States. He said, "We as county agents have had fundamental training in agriculture. We are grounded in soils, in crops and in animal husbandry, and if we are successful county agents, we have acquired some sound agricultural economics principles whether we took that type of work in college or not. With that type of background it is difficult to get the engineering point of view with sufficient clarity to be able to pass it on to the farmers of the county." He said further, "It is essential that the man who sells engineering ideas to the farmer must be fundamentally grounded in engineering, and while it might seem that, at least for a start, the agricultural engineer will be an assistant to the county agent, in all probability before long, in some instances at least, the county agent will be an agricultural engineer and the man grounded in the fundamentals of agriculture will be his assistant."

When the leaders in thought among the county agricultural agents of the country realize the enormous lack of agricultural engineering extension help, it behooves us not to sit back and say, "Look what progress we have made in this short time," but rather we should say, "How can we hold up our heads when almost every farm still needs engineering effort."

MEANS OF INCREASING THE EFFECTIVENESS OF AGRICULTURAL ENGINEERING EXTENSION WORK

I believe there are five distinct lines of approach which when followed will show surprising results:

1 In our colleges the teaching force of the agricultural engineering departments must go farther than they have in the past to make students realize the possible place for the trained agricultural engineer.

2 In our experiment stations whenever any project is considered that project should be analyzed, and those in charge shown that portion of the project which an agricultural engineer can do better than anyone else. All that any experiment station director wants to know is "Can you do the work better than someone else," and "Will you cooperate with the project leader?" When we satisfy him on these points, we will be an important factor in every research project.

3 Through increased publicity, both direct and indirect, we can and must show more leaders in fields other than agriculture the financial advantage of engineered agriculture.

4 In college extension work we must make the entire extension group appreciate what the farmer is losing through lack of adequate education and leadership in agricultural engineering, primarily within the individual counties.

5 In industrial extension (where that industry is directly dealing with agriculture) we must show the value to that industry of having extension specialists in the field, helping the farm pay through engineering.

If this is done, and done well, the 1200 agricultural engineers will have to be multiplied five times, and the major frontier of the agricultural engineer will be a frontier no more.

Development of Offset Disk Harrows

By O. W. Sjogren

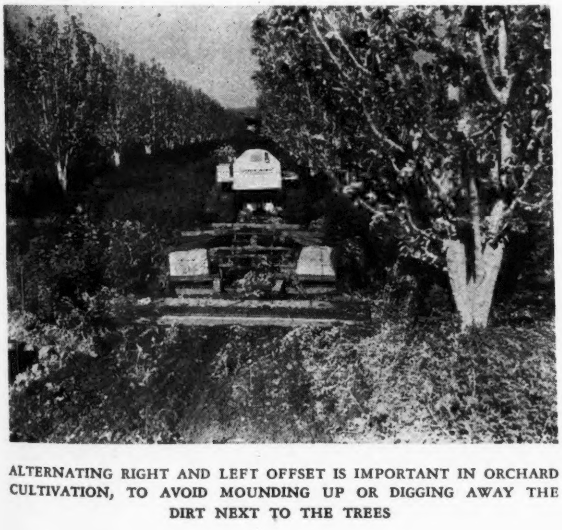
A DISCUSSION of any type of disk harrow must necessarily refer back to the earliest use of this type of implement, more than one-half century ago. The early harrows were of light construction and differed in many other respects from present day harrows. They were of the single-gang type, with a few disks or blades of comparatively small diameter, closely spaced. In order to work the ground thoroughly, it was usually necessary to double disk the ground. This requirement led to the development of the double-disk harrow, made up by adding a rear gang to trail the original single harrow. Once over the ground with this implement usually did the job.

The double-disk harrow was considered a great improvement over the single-disk type. It, however, required considerably more power, and its adaptation was limited so long as horses constituted the source of power. With the coming of tractor power the advantages of the disk harrow as a tillage tool became more and more apparent, and rapid strides were made in improving its design, construction, and operation. As its use broadened it was found to possess many advantages, not only for general field work, but also for orchard and vineyard cultivation.

The comparatively close spacing of the disks on the earlier types proved fairly effective for general mulching purposes and shallow cultivation. It was not, however, suitable for working in green manures or cover crops. Frequently the cover crop was so rank and heavy that the small disk blade could not cut through it at all and the results were far from satisfactory. In order to adapt the harrow for this type of work, large blades with wide spacing between them were necessary. The larger blades enabled the harrow to cut through a heavy growth of vegetation, and the wide spacing eliminated a large amount of clogging.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers, at Estes Park, Colo., June 1936.

Author: Agricultural engineer, supervisor of research and development, Killefer Mfg. Corp. Mem. ASAE.



ALTERNATING RIGHT AND LEFT OFFSET IS IMPORTANT IN ORCHARD CULTIVATION, TO AVOID MOUNDING UP OR DIGGING AWAY THE DIRT NEXT TO THE TREES

The double as well as the single-disk harrow, with the gangs divided in the center, leaves an unworked center ridge which is not at all desirable. Various devices are used to break this center, with more or less satisfactory results. The ground is also left in an uneven condition, the extent of which depends upon the depth worked.

In order to overcome these objections to the single and double-disk harrows, someone got the idea of making the front gang and the rear gang each as a complete unit. The front gang has the blades set to throw all the soil in one direction, and the rear gang has the blades set to throw the soil in the opposite direction. This type of harrow leaves no hard center ridge in the worked ground and leaves the ground in a comparatively level and smooth condition. Originally pulled directly back of the tractor, it was later found that it could be set to run considerably to one side of the center line of the tractor, hence the name "offset disk harrow."

It is not certain just when this type of harrow was first used, but as nearly as can be determined it was during the period between the years 1915 and 1920. The first offset harrow was simply made of two frames of disks, one set behind the other with the disks arranged to throw in opposite directions as indicated. The frames were flexibly connected by means of chains which could be adjusted to vary the angle between the gangs, with another set of chains serving as a hitch. The first analysis of this type of harrow was, so far as we know, made by E. G. McKibben and published in AGRICULTURAL ENGINEERING for March, 1926.

The principles of the present offset disk harrow remain fundamentally the same as in the first harrow, but the design and construction differ materially. As the farmer, rancher, and orchardist have become acquainted with this type of harrow, they have become more enthusiastic about its use, and in many sections it has become the universal tillage tool. The chief reasons for its popularity are, no doubt, the offsetting feature which permits it to work under low-hanging trees, and that it leaves the ground in a level or smooth condition. The offset disk harrow is widely used because it performs the functions of a plow and a cultivator under conditions where neither of these implements would perform satisfactorily. Its use, however, is not confined only to orchards. It is used extensively in open field work for seedbed preparation. This use may be confined to harrows in single units, or in several units combined as a squadron pulled by a large tractor.

As the use of this type of harrow has become more widespread, many changes have been made in its component parts. The modern user of disk harrows demands much in the performance of these tools. The requirements were not very clear at first, but as the manufacturer has built these tools and as the farmers have used them, the requirements have gradually taken definite form. What may now be considered as the main requirements of offset disk harrows may be set forth as follows:

1 Must work in all types of soil and handle cover crops satisfactorily
2 Must be of sufficient weight and of proper design to give continuous operation and long life
3 Must work at uniform depth throughout its entire width

4 Must stir the entire ground area to the depth worked
5 Must offset to the right or to the left with equal facility and operate without side draft
6 Must remain in cutting angle on hills or hard ground
7 Must be able to turn to the right and to the left with equal facility
8 Must be able to back up readily
9 Must be of low-down construction.

1 The requirement that this harrow work in all types of soil and handle cover crops satisfactorily has, perhaps, been responsible for most of the changes that have taken place.

The earlier harrows used the then common blade diameters of 14, 16, and in unusual cases, 18 in. With the adaptation of disk harrows to cover crops, the need of wider spacing became apparent. As the spacing increased, it was found that the diameter of the blades could be increased to great advantage. A combination of various factors has led to a gradual increase in the diameter of disk blades used, so that today blades of 22 and 24-in diameters are common and in some cases blades of 26 and 28-in diameter are used. The larger blades seem to be favored, mostly in the lighter soils, because of giving less penetration. As the diameter of the blades increased, the need for greater strength became apparent, with the result that improved methods of manufacture and of steel processing have added considerably to the strength and rigidity of the blades.

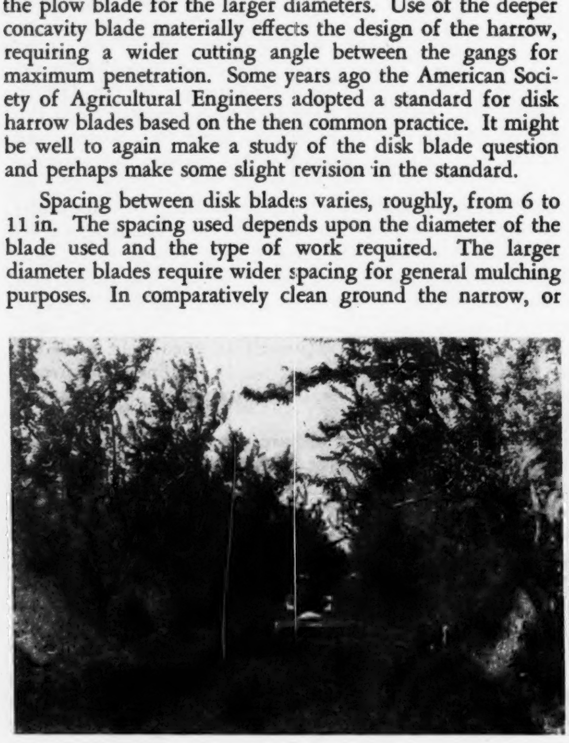
In connection with the change in the diameter of the disk blades came a change in the degree or depth of concavity. Disk harrow blades do not have the depth of concavity of disk plow blades. There is a tendency now to use the plow blade for the larger diameters. Use of the deeper concavity blade materially effects the design of the harrow, requiring a wider cutting angle between the gangs for maximum penetration. Some years ago the American Society of Agricultural Engineers adopted a standard for disk harrow blades based on the then common practice. It might be well to again make a study of the disk blade question and perhaps make some slight revision in the standard.

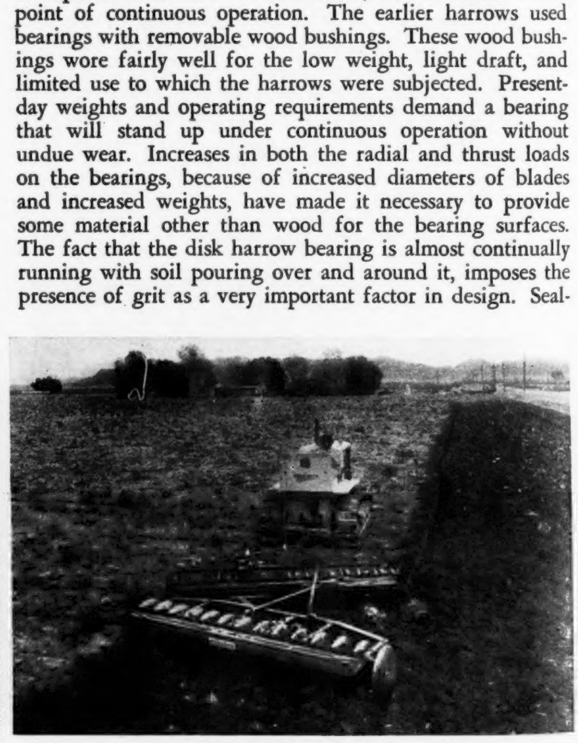
Spacing between disk blades varies, roughly, from 6 to 11 in. The spacing used depends upon the diameter of the blade used and the type of work required. The larger diameter blades require wider spacing for general mulching purposes. In comparatively clean ground the narrow, or 6-in spacing, is desirable. In working in cover crops the larger blades are required, and the wider spacing is not only desirable but absolutely necessary to prevent clogging, and to permit a thorough chopping up and mixing of the vegetation into the soil. The usual spacing for cover-crop harrows is 9 in and is used with blades of 20, 22 and 24-in diameters. In working in cover crops it is common practice to work the ground over at least twice, in order to do a good job and to cut the vegetation thoroughly.

Because of its weight the harrow may penetrate too deeply on light soils after the first time over. Where this is the case, it will be necessary to use some depth-regulating device, if the harrow is to be set at its full cutting angle and yet keep from penetrating too deeply. Various devices have been tried, but so far the most satisfactory depth gage is in the form of a split pulley, which is so arranged that it can be clamped to the spacing spool between the disk blades. It generally requires two to each gang or frame of disks. These are available in various diameters to suit the diameter of disk blades and the depth of penetration desired. On sandy or light soils, a reduction of approximately 20 per cent in the power requirement can be accomplished by the use of these gages, with no detriment to the quality of work performed.

2 The requirement of sufficient weight and proper design for continuous operation and long life demands well-built frames and long-life bearings. With increase in the diameter of disk blades there is also an increase in load requirements, calling for stronger frame construction. As the frames have been strengthened, they also have been made more rigid, without sacrificing flexibility of the harrow on uneven ground.

The matter of bearings is a very important one from the standpoint of the life of the harrow, and from the standpoint of continuous operation. The earlier harrows used bearings with removable wood bushings. These wood bushings wore fairly well for the low weight, light draft, and limited use to which the harrows were subjected. Present-day weights and operating requirements demand a bearing that will stand up under continuous operation without undue wear. Increases in both the radial and thrust loads on the bearings, because of increased diameters of blades and increased weights, have made it necessary to provide some material other than wood for the bearing surfaces. The fact that the disk harrow bearing is almost continually running with soil pouring over and around it, imposes the presence of grit as a very important factor in design. Seal-





INCREASING APPRECIATION OF THE VALUE OF WORKING IN HEAVY COVER CROPS, AND THE DEVELOPMENT OF TRACTOR POWER WITH WHICH TO DO IT, HAVE ENCOURAGED DEVELOPMENT OF THE MODERN OFFSET DISK HARROW

ing the bearing against the entrance of grit is a problem that has not yet been economically and practically solved. Grit will enter and it is necessary that the material of which the bearing is made be highly resistant to abrasion. It is now very common practice to use bearings made wholly of very hard metal which resists effectively the abrasive action of mixtures of grit and oil. This all-metal bearing gives uniformly satisfactory performance over a long period of time.

3 The requirement that the harrow work at uniform depth throughout its entire width requires that it be so designed as to distribute its weight evenly, and that the controls be such as to distribute the draft equally at the points of application. This requirement is approached more or less closely in the various harrows, by means peculiar to each manufacturer's design.

4 In order to stir the entire ground area in depth work, it is necessary that the spacing between the disks be correct for the diameter of the blade used, and for the cutting angle between the gangs. In order to regulate this, some provision is usually made to adjust the position of the gangs laterally with respect to each other so that there will be no core or ridge left in the ground after the harrow has passed over.

5 Where the harrow is used in the cultivation of orchards and is continuously operated offset in one direction, it has a tendency to either throw the soil to the trees, building up a mound under them, or to take it away from the trees, creating a basin around each tree. Either condition is highly undesirable, and can be prevented by operating the harrow alternately offset to the right and to the left as the orchard is worked during the season. It is, therefore, desirable that adjustments be provided so as to permit right-hand or left-hand offset in a simple, easy, and effective manner. The change in the amount of offset will affect the cutting angles of the front and rear gangs with respect to the line of draft. The design should be such as to minimize this variation and to maintain the cutting angles of the two gangs as nearly equal as possible under all conditions. This offsetting feature, however, is of minor importance where the harrow is used for open field work, as it is then usually pulled directly back of the tractor without any offset.

6 Some provision must be made to hold the gangs in cutting angle so that they will not close up when the harrow encounters hard ground, heavy cover crop, or hills. If the blades, for any reason, do not enter the soil, there is not sufficient resistance to hold them in cutting angle, with the result that the harrow tends to close up. In order to have the harrow operate properly, some provision must be made to keep the gangs in cutting position. This is accomplished by providing a lock or latch to be actuated by the operator as occasion requires.

7 The earlier offset disk harrows were so constructed that it was practically impossible to make a right-hand turn unless they were first closed up by backing, or they might be turned to the right and then after the turn had been negotiated it would be necessary to back the gangs into cutting position. In order to negotiate a right-hand turn, it is necessary at some stage to reverse the action of the hitch or other controls. While this is usually accomplished by stopping the tractor and backing up, this is not at all desirable, since it occasions some delay and is not always convenient. This reversal of action is now accomplished by means of various devices. These are so arranged that the moment the right-hand turn begins the gangs begin to close up just as though the tractor were backed up. This avoids the necessity for the operator to stop. As soon as the harrow has negotiated the turn, it must immediately return to its cutting position and lock. This operation must take place with a minimum amount of attention on the part of the operator and without loss of time. Whenever he desires to make a right-hand turn he should be able to keep going forward during the entire operation of turning and straightening out, to avoid loss of time and loss of temper. After the harrow is locked in cutting angle, as above stated, some provision must be made to release the lock at the instant the right-hand turn is begun. This is usually done by the operator releasing the latch. A recent development permits the latch or lock to be controlled by the right-turn arrangement. This makes it unnecessary for the operator to give any attention to the latch or locking device unless he desires to change the cutting angle between gangs or to straighten the gangs for transport.

8 The design of the harrow should be such that for right-hand turns the gangs will not only come to parallel position but go beyond, particularly where short turns are desired. When it becomes necessary to bring the harrow out of cutting position, in order to relieve a clogged condition or to close it up for transportation, it should be possible to do so without causing the gangs to assume a beyond-parallel position. In fact, it is absolutely necessary that they be prevented from going beyond parallel when backing up, in order to prevent buckling of the frames and damaging the hitch or other working parts.

9 The offset harrow is used to a considerable extent in orchard work under low-hanging trees, and it is, therefore, necessary that it be as low down as possible to prevent it catching low-hanging limbs, damaging them, or tearing off fruit. On the other hand, it must not be mounted so low that it tends to clog under unfavorable conditions. Low construction also permits it to be easily shielded by a sheet-metal guard so that the branches and fruit cannot catch on the frame or any other part of the harrow and be torn off.

These are a few of the features that have to be considered in the design of offset disk harrows. When one begins to work with this type of harrow, it looks quite simple at first, but as one gets into the design, he finds that there are so many factors entering into the operation of this type of equipment that it is impossible to determine their effects in a definite manner. In designing and constructing the offset disk harrow, it appears as though we were attempting to reverse the law of forces. The reason that the offset disk harrow development has been so difficult is perhaps due to the fact that we have attempted to operate the mechanism positively and negatively, so to speak, but with the actuating force traveling in one direction only. We want the load to be pulled to one side of the center line of draft, and yet we want no side draft. We want the gangs to open up on the forward pull and when we come to a point where it is necessary to reverse this action of the gangs in order to make a turn, we still want to go ahead. We seem to forget that, if we are to raise ourselves by our bootstraps, we must change the method of applying the force.

There are many factors involved in the operation of any disk harrow, the effects of which are but little known. Often they are merely guessed at. There is a definite need for full, accurate, and authentic information covering the factors that affect the design and operation of all disk harrows. Projects aiming at securing such information should prove a very logical activity to be sponsored by the Power and Machinery Division of the American Society of Agricultural Engineers.

Electricity in Better Farm Management

By Hobart Beresford

THE QUESTION of the influence of electricity on farm management immediately brings up the problem of determining the effect of management on the farm enterprise. It has been demonstrated frequently that the management factor determines the success or failure of farm operation. Further, it is generally conceded that the common measurement of the management factor is the financial outcome of the enterprise. All of this becomes so involved that, for want of a properly controlled scientific study of the question, this discussion shall be confined to cases.

In general, managerial capacity is determined by the number of ideas that can be associated in the mind at the same time, and which, through proper correlation, may result in the direction of desired action. Electricity, through its remote control, and automatic time, temperature, and pressure control in furnishing power, heat, and light for various farm operations and processes, can very readily release mental activity to the management of the farming business. In other words, the application of electric service to the farm can relieve the farm manager of routine cares and worries, thus giving him more time to think, plan, and live.

The timeliness factor, and the cost or economic factor, are those to which electric service contributes most, and these factors probably have the greatest influence on the labor income. Electric refrigeration may influence the purchase or sale of food products. The much discussed electric fence may have its influence on crop rotation and weed control. There are many other applications of electricity that contribute to farm management, such as poultry lighting, hotbed and soil heating, dairy sterilization, etc.

In connection with the federal rural electrification survey authorized under the Federal Power Commission, we find a classification of farms for the purpose of determining the electrical energy consumption on various types of farms. This classification was made for the purpose of determining what a completely electrified farm might use on a twelvemonth basis. Through the cooperation of the Idaho Power Company typical farms were selected in various parts of the state and an inspection made of the connected loads on these farms, the power used annually, and the cost of this power.

This study revealed that completely electrified dairy farms led the list in energy consumption with a total of 10,000 kwh (kilowatt-hours) annually. Contrary to expectations, the self-sufficing farm used 2,500 kwh as compared with cash grain farm consumption of 1,500 kwh, which was the lowest. The truck farm used 3,500 kwh; the stock ranch, 5,000 kwh; the general farm, 5,500 kwh; the crop specialty farm, 6,000 kwh; fruit and poultry farms, 7,000 kwh each; and the animal specialty farm, 8,500 kwh. These energy consumptions are, in general, the average of five completely electrified farms of each type, widely distributed throughout the state.

In the study referred to no attempt was made at the time to determine the farm income, except in the case of the self-sufficing farm, which was selected on the group basis of a noncommercial enterprise. The cash grain farm had the lowest kilowatt-hour consumption of the various groups, which was slightly less than the average for the consumption of all farms in Idaho. This indicates that this service is entirely domestic and that electric service on this class of farms does not contribute directly to the farming operations, in spite of the fact that the labor income on these farms may be relatively high.

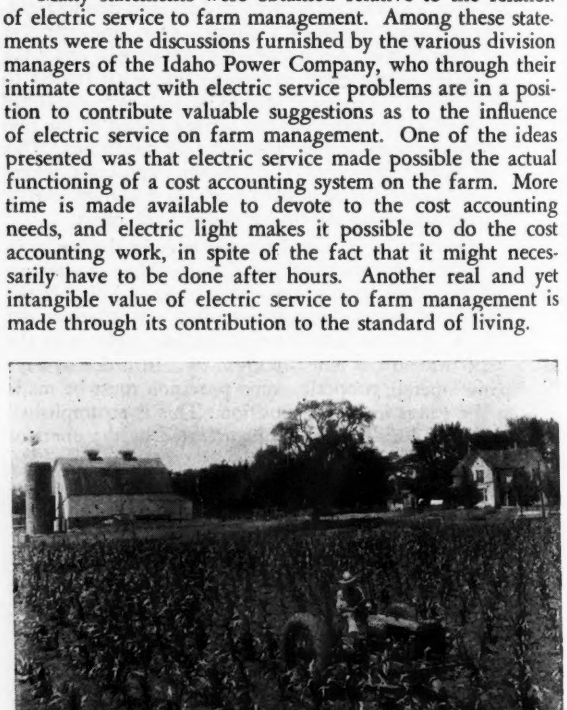
In connection with the consideration of farm management, many statements have been obtained from cooperatives in the first study. From these statements we have a fair indication of what farm owners and managers think of the question of electric service and farm management.

In the animal specialty group the connected loads averaged 36,279 w (watts) with an average enery consumption of 8,304 kwh per year.

On the dairy farms the average connected load was 20,020 w with an average consumption of 9,897 kwh.

In the general farm group the connected loads averaged 21,146 w with an annual energy consumption of 5,405 kwh. Thus we see there is a wide variation in the relation between the connected load, resulting investment in equipment, and the utilization of electric service by this equipment.

Many statements were obtained relative to the relation of electric service to farm management. Among these statements were the discussions furnished by the various division managers of the Idaho Power Company, who through their intimate contact with electric service problems are in a position to contribute valuable suggestions as to the influence of electric service on farm management. One of the ideas presented was that electric service made possible the actual functioning of a cost accounting system on the farm. More time is made available to devote to the cost accounting needs, and electric light makes it possible to do the cost accounting work, in spite of the fact that it might necessarily have to be done after hours. Another real and yet intangible value of electric service to farm management is made through its contribution to the standard of living.



ELECTRIFICATION LEAVES THE FARMER MORE TIME AND ENERGY FOR THINKING, PLANNING, FIELD WORK, AND LIVING

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers, at Estes Park, Colo., June 1936.

Author: Professor and head of the department of agricultural engineering, University of Idaho. Mem. ASAE.

Cooperation in the Extension of Electric Service to the Farm

By David S. Weaver

AS AGRICULTURAL engineers, the words "rural electrification" cannot fail to bring clearly to your minds a picture of a modern farm and a modern farm home, where the daily labors of the farmer and the farm woman have been materially lightened as a result of the fullest possible use of electricity as a source of light, power, and heat. Not only the reduction of farm drudgery is possible, where electricity is available, but the whole tone and morale of a farm community can be immeasurably improved, bringing about higher economic, social, and spiritual standards of living, which is the aim and goal of all agricultural education.

A well-planned, long-time program of electrical development is made possible by the resources of the Rural Electrification Administration, but its best execution, with most complete results, can only be made possible by the fullest cooperation on the part of all interested agencies. This program will not merely mean the construction of distribution lines, but the wiring of farm homes and buildings, the selection and installation of electrical appliances and the introduction of modern bathroom and kitchen plumbing fixtures. Running water, made possible by electrically driven pumps, will do much to revolutionize farm home life. Financing of the purchase of this equipment, at low interest rates and easy terms, is now possible.

There are many agencies interested in the benefits which electricity can bring to the rural areas of America. Those which have been most active in the past and which give evidence of being most helpful in the future may be divided into four general groups: (1) Farmer's organizations such as the American Farm Bureau Federation, the National Grange, National Farmer's Union and certain cooperative associations; (2) the agricultural press, composed of leading farm journals and county newspapers; (3) the state and federal organizations for agricultural education, including the agricultural colleges, extension services and experiment stations, and the vocational agricultural high schools; and (4) the electrical industry which includes private utilities, municipally-owned plants, and appliance manufacturers.

While the exact part that each of the above will play in the development of the program is unknown at present, the final picture will bear the imprint of the influence of all. Without that influence the picture can never be quite complete because every one of these agencies has found a place in rural life and each should contribute its part to this new movement which affects them all. To date certain of these groups have played a more important part than others in a given state. In other states other groups have been most active. Perhaps this is as it should be, so that we can learn by experience which group or combination of groups are best able to cope with certain situations.

In order to outline the cooperative part which members of this society can play in the rural electrification program it might be well at this point to briefly outline the Rural Electrification Act of 1936 under which REA will operate for the next ten years. The following analysis was made by Mr. Allen Moore, legal adviser to the development section of REA.

"The Rural Electrification Act of 1936, approved May 20, 1936, (Public Law No. 605) (74th Congress) creates and establishes an agency of the United States known as the 'Rural Electrification Administration' under the direction of an administrator. The administrator is appointed by the President with the advice and consent of the Senate, for a term of ten years at a salary of $10,000 a year.

"The administrator is authorized and empowered to make loans in the several states and territories for rural electrification and the furnishing of electric energy to persons in rural areas who are not receiving central station service. A rural area is defined as any area of the United States not included within the boundary of any city, village or borough having a population in excess of 1,500 inhabitants, and the term includes both the farm and nonfarm population thereof. The administration is also authorized and empowered to make studies, investigations, and reports concerning the condition and progress of the electrification of rural areas, and to publish and disseminate information with respect thereto."

The Act provides for two types of loans: (1) to persons, corporations, states, territories, and subdivisions and agencies thereof, municipalities, peoples utility districts and cooperative, non-profit, or limited-dividend associations, for the construction and operation of generating plants, electric transmission, and distribution lines or systems for the furnishing of electric energy to persons in rural areas who are not receiving central station service; (2) to any of the borrowers of funds loaned by the administrator, or to any person, firm, or corporation for the wiring of the premises of persons in rural areas and the acquisition and installation of electrical and plumbing appliances and equipment.

In making the loans for the construction and operation of generating plants, electric transmission and distribution lines, and systems, preference must be given to states, territories, and subdivisions and agencies thereof, municipalities, people's utility districts, and cooperative, nonprofit or limited-dividend associations. These loans are made on such terms and conditions as the administrator determines, and may be made payable in whole or in part out of income. All such loans must be self-liquidating within a period of not to exceed twenty-five years, and must bear interest at a rate equal to the average rate of interest payable by the United States of America on its obligations, having a maturity of ten or more years after the date thereof, issued during the last preceding fiscal year in which any such obligations were issued. Loans for generating plants may not be made unless the consent of the state authority having jurisdiction thereof is first obtained. Loans for generating plants and lines may not be made unless the administrator finds and certifies that in his judgment the security therefor is reasonably adequate and that such loan will be repaid within the time agreed.

Loans for wiring, appliances, or equipment are made for such terms, subject to such conditions, and so secured as

Presented before the Rural Electric Division at the annual meeting of the American Society of Agricultural Engineers, at Estes Park, Colo., June 1936.

Author: Agricultural engineer, Rural Electrification Administration. Assoc. Mem. ASAE.

reasonably to assure repayment thereof. The rate of interest will be the same as that charged for generating plants and lines. The Rural Electrification Administration will obtain its funds from two sources: (1) for the fiscal year ending June 30, 1937 from the Reconstruction Finance Corporation in an amount not to exceed $50,000,000, (2) thereafter from annual appropriations by Congress for a period of nine years in amounts not to exceed $40,000,000 per year.

The obligations for loans for generating plants, electric transmission and distribution lines, or systems must be fully amortised over a period not to exceed twenty-five years, while those for wiring, appliances, and equipment must not exceed two-thirds of the assured life thereof and not more than five years.

Fifty per cent of the annual sums made available by the Act will be allotted yearly by the administrator for loans in the several states in the proportion which the number of their farms not then receiving central station electric service bears to the total number of farms of the United States not then receiving such service.

The remaining fifty per cent of such annual sums will be available for loans in the several states and in the territories without such allotment, but not more than ten per cent of such unallotted annual sums may be employed in any one state or in all the territories.

The Act provides that if any part of the annual sums made available for loans shall not be loaned or obligated during the fiscal year for which they were made available such unexpended or unobligated sums will be available for loans in the following year or years without allotment, but not more than ten per cent of said sums may be employed in any one state or in all of the territories. Loans from the Reconstruction Finance Corporation to the administrator are limited to the fiscal year ending June 30, 1937.

As the principal and interest of the loans made by the administrator under the Act are received they will be covered into the Treasury as miscellaneous receipts, but as a matter of course, payments received on obligations which have been turned over to the Reconstruction Finance Corporation will be paid to that Corporation.

Loans for generating plants, electric transmission lines or systems may be extended for a period not to exceed five years after such payment shall have become due, while loans for wiring, appliances and equipment may be extended for a period not to exceed two years. These provisions, however, do not apply to the obligations held by the Reconstruction Finance Corporation.

Provision is made for annual appropriation by Congress for the administrative expenses of the administration. In the event of default in the payment of the loans, the administrator is authorized and empowered to bid for and purchase at any foreclosure or other sale or otherwise to acquire the property in the name of the United States of America and to operate or lease such property for a period not to exceed five years. Such property may be sold at the discretion of the administrator. No borrower of funds may, without the approval of the administrator, sell or dispose of its property, rights, or franchises acquired under the Act until any loan obtained from the Administration, including all interest charges, shall have been repaid.

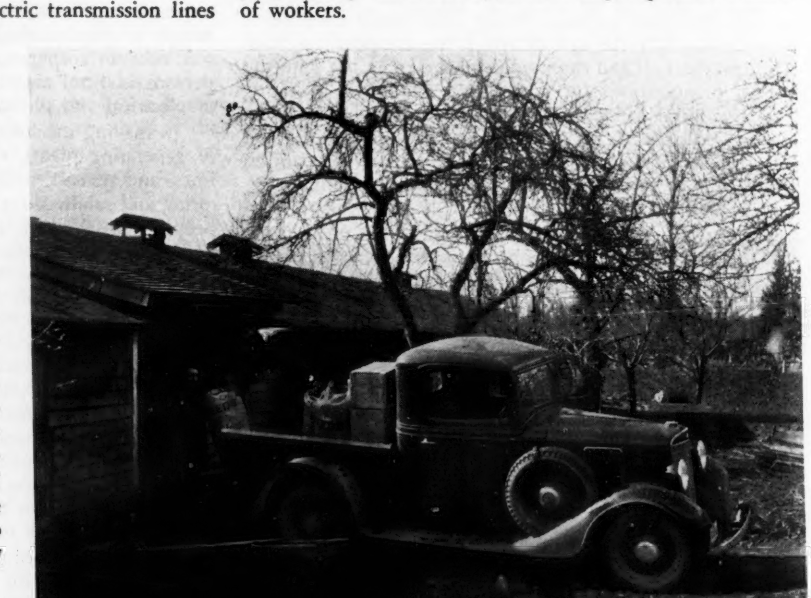
The President is authorized to transfer to the Rural Electrification Administration created by the Act the jurisdiction and control of the records, property, and personnel used or employed in the exercise of the functions of the Rural Electrification Administration established by Executive Order No. 7037, dated May 11, 1935. The administration of the loans and contracts made under the executive order may be vested by the President in the new Administration.

The Act provides that it shall be administered entirely upon a nonpartisan basis, and in the appointment of officials, the selection of employees, and in the promotion of any such officers or employees no political test or qualification is permitted or may be given. The administrator may be removed from office for a violation of this provision of the Act and any appointee or selection of officials or employees made by the administrator who is found guilty of the violation of the Act in this respect is required to be removed by the succeeding administrator.

The administrator must make a full report of his activities under the Act not later than January 20 of each year.

The administrator may accept and utilize such voluntary and uncompensated services of federal, state, and local officers and employees as are available in order to carry out provisions of the Act. Officers and employees other than attorneys, engineers, and experts are subject to civil service laws.

As members of the Rural Electric Division of the American Society of Agricultural Engineers we are interested in either or both of the two dominant objectives of the program fostered by this Act. The first is to accelerate the movement to bring the economic benefits and living comforts of electricity to farmers to whom they have heretofore been denied. The second is to promote national recovery by creating new and profitable business for producers of supplies, equipment, and appliances, and by providing useful jobs, directly and indirectly, for the largest possible number of workers.



ELECTRIFICATION IS A STEP TOWARD FARMS BECOMING BETTER ENGINEERED IN ALL RESPECTS

Erosion Control in the Tennessee Valley

By J. H. Nicholson

THE EROSION control activities of the Tennessee Valley Authority are carried on by two divisions, agricultural and forestry. All erosion problems involving farm management, terracing, cropping systems, pasture improvement, fertilization, etc., are the direct responsibility of the agricultural division. The activities of the forestry division are confined largely to sub-marginal lands and areas which are generally accepted as suitable only for forest crops. Under a comprehensive land-use program each of these divisions is cooperating with existing agencies, including the land-grant colleges, extension services, and local erosion control associations, in the promotion of the conservation program.

Erosion control work of the forestry division is in the hands of the planting section, more recently named the watershed protection section. It is the work of this section which I will explain.

The Tennessee Valley, containing a great variety of soil types ranging from the shales of the Appalachians through the gravelly, dolomitic soils of the ridge sections, the pure limestone clays of the valleys to the highly erosive silts of north Mississippi and west Tennessee, presents almost as many problems as there are soil types. Erosion types in the Valley include the vicious V-shaped gullies in mountainous sections, produced by continuous corn and tobacco cropping on excessive slopes; sheet erosion on the rocky, shallow soils of overgrazed pasture lands; the heavily sheet-eroded stretches of comparatively flat lands in northern Alabama, produced by continuous cropping to cotton; and the melting away of the deep, sandy soils of west Tennessee.

The forestry division began its erosion control program in the fall of 1933, when twenty CCC camps were assigned to the TVA for erosion control and reforestation work. These camps were located in the Clinch-Powell watershed for the purpose of effecting erosion control to protect Norris Lake, just completed.

Most of the work of these camps was confined to lands which had been purchased by the TVA or were designated for future purchase. In the earlier stages of the work little thought was given to securing farmer cooperation or to the intrinsic value of the land being reclaimed. The major objective was to stop the shower of soil, gravel and stone pouring down from the steep hillsides adjacent to the lake into the live storage area of the basin. Heroic and expensive measures were used to effect this control, the major portion of which has been completely effective. In the spring of 1935, when it became apparent that the greater portion of the sub-marginal land in the area had been put under control, it was decided to extend the work over the entire Valley. A survey was made and critical erosion areas were selected for the location of the twenty CCC camps and eighteen additional camps which were assigned to the TVA at that time.

It was realized that under the broader program a less expensive technique must be developed, a technique more in keeping with the intrinsic value of the areas to be worked and more applicable to the means of the individual farmer. Considerable progress had been made in the simplification of erosion control technique during the 18-month period of operation in the Norris watershed, but even further progress along this line was recognized as necessary to extend the benefits of the program to a large proportion of farmers throughout the Valley. At this time an agreement was made for the cooperation of the forestry division with the agricultural division and extension services for the CCC camps, to help with the terracing program by doing demonstration work in terrace outlet control.

Results of the early work in the Norris watershed, as well as results obtained by other agencies and individuals working on erosion control in various parts of the Valley, indicated that comparatively little engineering work is necessary to control badly eroded areas under most conditions. The Tennessee Valley is fortunate in having a heavy and well-distributed annual rainfall. This factor, along with a wealth of native vegetation, makes the control of these areas comparatively simple. All except the most aggravated cases will normally be revegetated naturally within a period of a few years if protected from fire and grazing. With these facts in mind the program of the forestry division in erosion control was designed to give a minimum amount of aid to the natural processes of healing.

Realizing that eventually the responsibility of erosion control must fall to the individual landowner, the program was devised to require as much cooperation from him as it was possible to get. Each project now accepted by the forestry division for work requires that the landowner supply all materials and team work necessary for the promotion of the project and that he sign an agreement to protect the area from fire and grazing until sufficient time has been allowed for the healing process. Only the trees for planting these projects are supplied by the TVA.

The technique now in use involves a minimum of structures and in many cases projects are planted without any engineering work. The structures in use are mainly diversion ditches, brush dams and hogwire dams. Gullies under 5 feet for the most part are plowed in and mulched with straw or brush or both, depending upon the drainage area involved. In the larger gullies (5 feet and over), brush and hogwire dams are being used to temporarily stabilize the bottoms to provide a planting area. No bank sloping is done on these larger gullies. They are allowed to slope themselves naturally by frost action. As work progresses it is becoming more and more evident that control may be brought about effectively by these measures and that in most cases the reestablishment of vegetation in the bottoms of the gullies and on the watershed above the gullies will quickly and effectively bring about their control.

Planting is done mainly with the pioneer species, locust and pine. Projects where plowing and mulching are done are seeded to grasses and lespedezas to aid in holding the area until the trees become established.

The terrace outlet control program which was started a year later than the gully control work has not developed as rapidly. A considerable handicap to this program has been divided responsibility for planning the terracing systems. The terrace systems are designed by assistant county agents employed by the TVA and working directly under the

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers, at Estes Park, Colo., June 1936.

Author: District erosion engineer, watershed protection section, forestry division, Tennessee Valley Authority. Mem. ASAE.

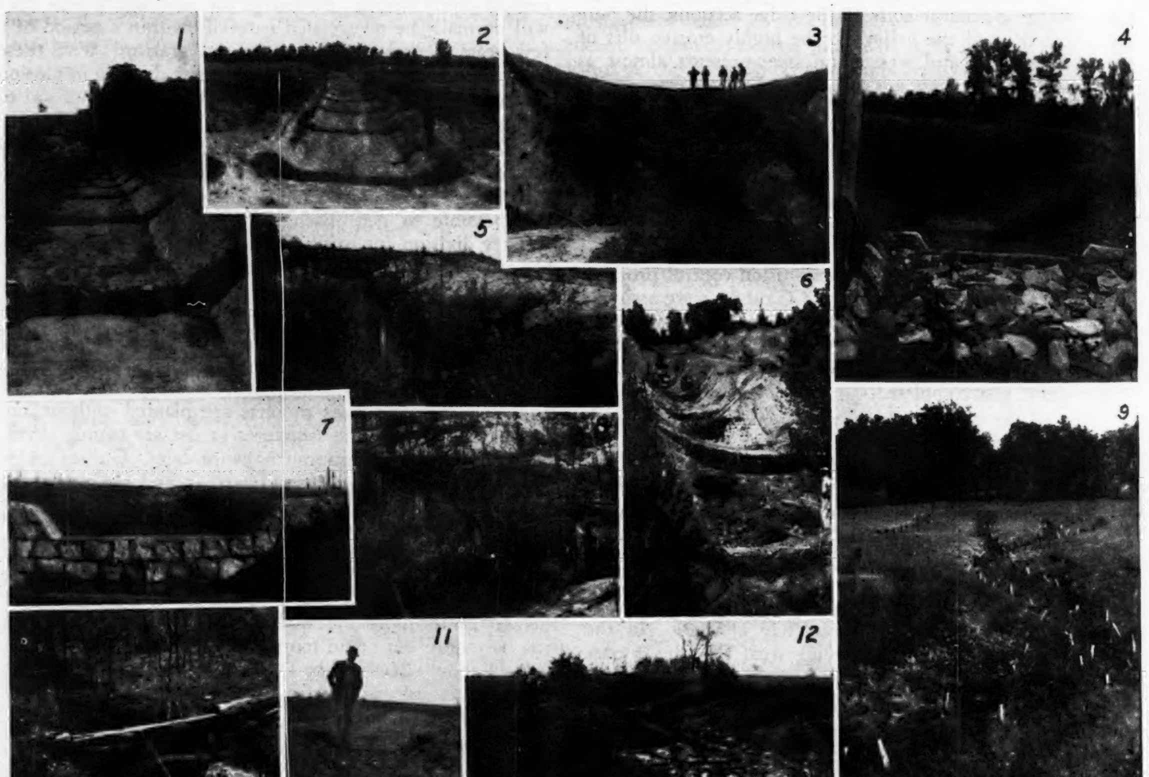
extension service. There has been, in many instances, a lack of coordination in the planning of the terraces to affect the most feasible outlet control. The practice in vogue in the area for years, of emptying terraces into highway ditches and old gullies, has not yet been entirely eliminated. Considerable difficulty is being encountered in persuading the landowner to accept a practical system of outlet control which the author believes to be, in most instances, a controlled outfall within the limits of his property.

Early work of the forestry division in terrace outlet control was an effort to demonstrate the advantages and feasibility of permanent structures. Realizing that the problem of maintenance would be much simpler where permanent structures are used, a large part of the work was devoted to this type of control. After considerable demonstration work had been done the same policy was adopted with regard to materials as that of the gully control work. As it became increasingly difficult in many areas for the farmers to supply the needed materials for permanent work it became evident that other types of outlet control would be necessary. The measures now used on any farm are dependent upon the materials which the owner is able to supply.

The technique of terrace outlet control has been considerably improved and simplified through our own experience and observation of the work of other agencies. In most cases broad, shallow outfall ditches are being constructed and are being controlled by simple masonry or concrete ditch checks placed on O-O grade and constructed without aprons. This type of work can be done at about one-third the cost of masonry dams. Where vegetation is used, sod strips are placed across the outfall ditch and so located as to allow a flat grade between strips, the fall in the ditch being taken up by allowing a 6-inch drop in each strip. These strips are usually planted with bermuda grass or honeysuckle and held down with hogwire until they become established. Where drops occur from the terraces into controlled outfall channels a log or rock header is placed to establish the terrace channel and a chute or apron constructed of loose rock or sod. In many instances meadow outlets are being recommended and this type of work is carried on entirely by the landowner, with the cooperation of the county agent in establishing the suitable vegetation.

In general the program has been enthusiastically accepted by the farmers throughout the Valley. Hundreds of applications for cooperative work are received each month by the forestry division.

Perhaps the most encouraging feature of the program is the adoption of the erosion control measures in use by the camps, by hundreds of individual farmers throughout the Valley who are not within reach of the camps.



SOIL EROSION CONTROL MEANS EMPLOYED IN THE TENNESSEE VALLEY

(1) SOD STRIPS IN TERRACE OUTFALL DITCH. (2) OUTFALL DITCH STRIP SODDED WITH BERMUDA GRASS AND WIRED DOWN. (3) A VERTICAL HEAD SLOPED, MULCHED WITH STRAW AND BRUSH, AND PLANTED. (4) HEADER AND LOOSE ROCK APRON IN TERRACE OUTLET ONE YEAR AFTER CONSTRUCTION. (5) BRUSH DAM AFTER TWO YEARS, SHOWING GROWTH ESTABLISHED. (6) WIRE, BRUSH AND LOG DAMS IN A DEEP GULLY, WITH NO BANK SLOPING. (7) ROCK MASONRY DAMS IN TERRACE OUTFALL DITCH. (8) A WIRE DAM AFTER TWO YEARS. (9) BRUSH STAKED DOWN IN A GULLY DRAINING A CONSIDERABLE AREA, WHERE NO DIVERSION DITCH WAS FEASIBLE. (10) FAILURE OF LOG DAM AFTER ITS PURPOSE WAS ACCOMPLISHED. (11) LOG HEADER WITH SODDED APRON. (12) A GULLY CONTROLLED BY LOCUSTS AND BRUSH DAMS. NO MATTING WAS USED

Cost of Terracing with Power Equipment

By Deane G. Carter and W. C. Hulburt

THE COST DATA reported are based upon an analysis of 240 terracing jobs in seven Arkansas counties, where 40-hp diesel tractors operating 10-ft blade terracers are in operation.

In 1935 the Rural Rehabilitation Corporation, now a part of the Resettlement Administration, advanced funds for the purchase of seven power-operated terracing units. Soil improvement associations were organized in each of these counties to handle the equipment. Primarily the activities of the association are centered in the office of the agricultural extension agent.

The seven outfits were established in four of the major type-of-farming areas in Arkansas, where the principal farming is classified as general, cotton, and self-sufficing. The soils are primarily the loams and sandy loams of the Gasconade, Clarksville, Baxter, and Hanceville series. Land slopes varied from 2 to 8 per cent in a majority of cases. The average terracing job ranged from 26 to 30 acres, with very little difference in the various areas.

Work included typical terrace construction, usually "seven-cut" or three and one-half rounds of the machine, and built according to the usual recommendations for vertical interval, grade, width, and cross section. Outlets and fills were built by the individual farmer, and not counted as a part of the association job.

Costs of terracing under the conditions described are analyzed in three ways: (a) the cost to the farmer; (b) the operating cost to the association; and (c) a calculated cost, including operation and overhead.

Cost to the Farmer. The associations are required to make a uniform charge of $3.00 per hour to the land owner for the use of the equipment and the operating crew. This charge is made for the time the tractor is in actual operation, but includes the service of surveying the field and laying out the terrace lines. The 240 jobs required 2216.35 hr, for which the farmers were charged $6,649.05. The acres terraced amount to 6670. The net average cost per acre was $0.997, or almost exactly $1.00 per acre. From data on lineal distances, the costs are indicated as $17.85 per mile, one cent per yard, or 33.8 cents per 100 ft of terrace. Table 1 gives the details of costs to the farmer for each association.

Operating Costs. The costs to the association include the wages of a crew of four men, which averaged $1.40 per hour for labor; gasoline for starting, 18 cents per gallon; fuel oil, 7 to 8 cents per gallon; grease, 10 cents a pound; and oil, 50 cents per gallon. Repair and miscellaneous costs varied with each tractor.

For the jobs analyzed, the operating costs amounted to $4,312.12, or 64.6 cents per acre, $11.57 per mile of terrace, ⅔ of a cent per lineal yard, or 21.9 cents per 100 lineal feet. The hourly operating cost totaled $1.95 per hour. The expenses of the association were 73 per cent for labor, 19

Research paper No. 440, Journal series, University of Arkansas. First publication in AGRICULTURAL ENGINEERING.

Authors: Respectively, professor and head of the department of agricultural engineering, (Mem. ASAE) and instructor in agricultural engineering (Assoc. Mem. ASAE), University of Arkansas.

TABLE 1. FARM COST FOR POWER-OPERATED TERRACE CONSTRUCTION*

				Terracing				Farmer Cost			
County	Terracing jobs	Hours	Total charge	Acres	Miles	Yards	100-ft	Per acre	Per mile	Per yard, cents	Per 100 ft. cents
1	6	79.00	$ 237.00	150	11.01	19,385	581.55	$1.58	$21.53	1.223	40.8
2	40	321.50	964.50	1074	64.89	114,199	3,425.97	0.90	14.86	0.845	28.1
3	76	627.25	1881.75	2105	86.04	151,433	4,542.99	0.89	21.87	1.243	41.4
4	70	707.75	2123.25	1755	141.47	248,987	7,469.61	1.21	15.01	0.853	28.4
**5	—	—	—	—	—	—	—	—	—	—	—
6	43	413.00	1239.00	1390	58.97	103,789	3,113.67	.89	21.01	1.194	39.8
7	5	67.85	203.55	196	10.17	17,905	537.15	1.04	20.01	1.137	37.8
Totals	240	2216.35	$6649.05	6670	372.55	655,698	19,670.94	—	—	—	—
Averages								$0.997	$17.85	1.014	33.8

*Terrace construction only—no outlet construction nor fills constructed with power equipment.

**County 5 had completed 21 terracing jobs, but no lineal measurements of the terraces had been made, so the remaining available data have been omitted in Tables 1, 2, and 3.

TABLE 2. ASSOCIATION OPERATING COSTS WITH POWER EQUIPMENT — TERRACING JOBS*

			Operation costs				Operation cost per unit				
County	Terracing jobs	Hours	Labor	Supplies	Repair and misc.	Total	Acre	Mile	Yard, cents	100 ft, cents	Hour
1	6	79.00	$ 91.45	$ 26.54	$ 0.00	$ 117.99	$0.787	$10.72	0.609	20.3	$1.49
2	40	321.50	364.55	159.63	5.00	529.18	0.493	8.16	0.463	15.4	1.65
3	76	627.25	879.00	201.00	91.40	1171.40	0.556	13.61	0.774	25.8	1.87
4	70	707.75	1056.50	226.05	145.20	1427.75	0.814	10.09	0.573	19.1	2.02
5	—	—	—	—	—	—	—	—	—	—	—
6	43	413.00	650.80	176.50	111.60	938.90	0.675	15.92	0.905	30.2	2.27
7	5	67.85	84.75	24.65	17.50	126.90	0.647	12.48	0.709	23.6	1.87
Totals	240	2216.35	$3127.05	$814.37	$370.70	$4312.12	—	—	—	—	—
Averages			73%	19%	8%	100%	$0.646	$11.57	0.658	21.9	$1.95

*Terrace construction only—no outlet construction nor fills constructed with power equipment.

per cent for supplies, and 8 per cent for repairs and miscellaneous. The margin between the $3.00 per hour charge and $1.95 operating cost is $1.05 per hour, the amount available as a fund for retiring the first cost of the machine. Table 2 indicates the operating costs.

Calculated Total Cost of Terracing. The total cost of terracing by this method is obtained by adding to the operating cost an arbitrary calculated cost for overhead items sufficient to pay out on a commercial basis. The delivered price for the equipment was approximately $4200 per outfit. Interest charges are roughly calculated at five per cent on the average value of the equipment, assuming a straight-line depreciation, or 2½ per cent on the first cost. Agencies engaged in this type of work have assumed a life of 10,000 hr. On this basis, and for the actual hours operated by the outfits, the overhead averaged 71 cents per hour. If this overhead cost is added to the operating cost of $1.95, the total is $2.66, leaving a margin of 34 cents per hour (Table 3).

The three associations doing very little work had unusually high overhead charges, while four that did considerable work are able to show a moderate overhead cost (Table 4).

The authors believe that in order to be conservative, and for the conditions under which the equipment is operated, a life of 5,000 hr should be used, and the equipment should be operated at least 1,000 hr per year. On this basis depreciation would amount to 84 cents per hour, interest about 10 cents per hour, and total costs would be $2.89.

Although the 1,000-hr annual duty is considerably more than was accomplished in the first year, the stimulus of the soil conservation program, the result of demonstrations conducted, the experience of the association, and the use of the tractors for levee and ditch building and grinding of limestone, will tend to greater use of the equipment.

TABLE 3. SUMMARY OF COSTS AND RETURNS OF TERRACING JOBS

Costs on 240 jobs, 2216.35 hours, 6670 acres, 372.55 miles, 655,698 lineal yards, or 19,670.94 feet

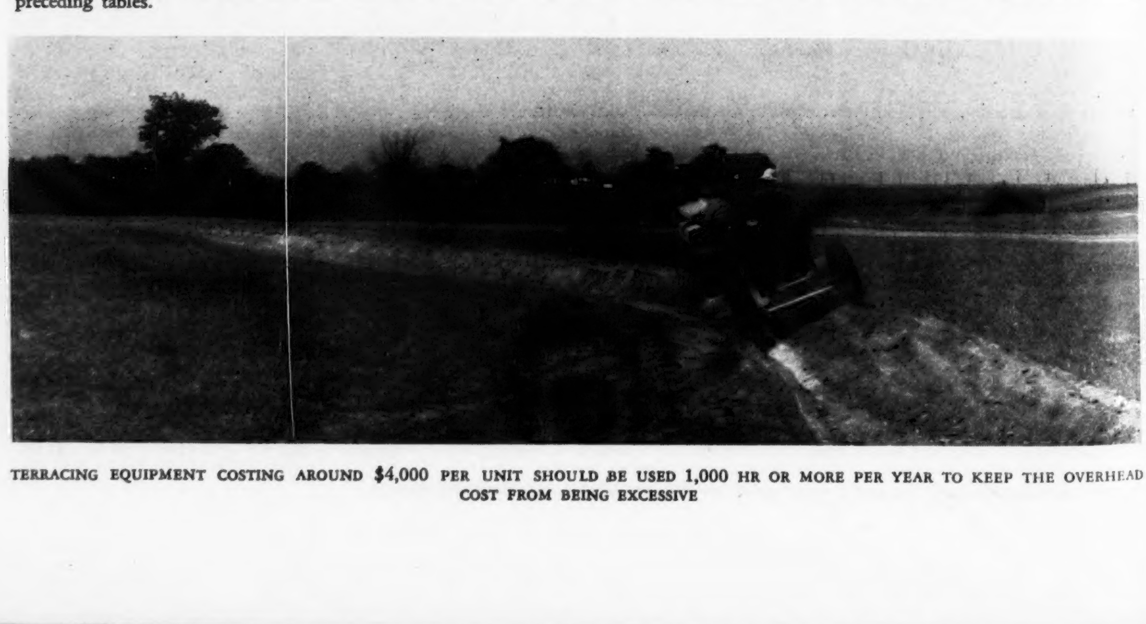
	Total	Per job	Per hour	Per acre, cents	Per mile	Per yard, cents	Per 100-ft, cents
Farmer cost	$6649.05	$27.70	$3.00	99.7	$17.85	1.014	33.8
Operating cost	4312.12	17.97	1.95	64.6	11.57	0.658	21.9
Margin	2336.93	9.73	1.05	35.1	6.28	0.356	11.9
Total cost*	5905.82	24.61	2.66	88.6	15.85	0.901	30.0
Net	743.23	3.09	0.34	11.1	2.00	0.113	3.8

*Total cost includes operating cost and overhead cost. The latter is based on 10,000 hours life and interest at 5 per cent on net balance, or 2½ per cent on first cost, and calculated on actual hours operated in 15 months.

TABLE 4. TERRACING EQUIPMENT COSTS AND RETURNS — ALL JOBS*

County	All jobs	Hours	Farmer charge per hr	Farmer charge total	Operation cost total	Operation cost per hour	Net operating returns	Overhead per hour	Total cost per hour	Net per hour
1	6	79.00	$3	$ 237.00	$ 117.99	$1.49	$1.51	$2.00	$3.49	$—0.49
2	40	321.50	3	964.50	529.18	1.65	1.35	0.79	2.44	0.56
3	90	740.25	3	2220.75	1381.35	1.87	1.13	0.60	2.47	0.53
4	76	766.25	3	2298.75	1547.92	2.02	0.98	0.59	2.61	0.39
5	21	205.04	3	615.11	457.65	2.23	0.77	1.02	3.25	—0.25
6	51	478.92—	3	1436.75	1078.93	2.25	0.75	0.70	2.95	0.05
7	9	118.60	3	355.80	216.94	1.83	1.17	1.41	3.24	—0.24
Ave. and totals (7)	293	2709.56—		$8128.66	$5329.96	$1.97	$1.03	$0.71	$2.68	$0.32
Ave. and totals 2, 3, 4, and 6	257	2307.00		$6920.75	$4537.38	$1.97	$1.03	$0.60	$2.57	$0.43

*All jobs include terracing, ditching and levee construction, which accounts for the slight difference in figures on this table with the three preceding tables.



TERRACING EQUIPMENT COSTING AROUND $4,000 PER UNIT SHOULD BE USED 1,000 HR OR MORE PER YEAR TO KEEP THE OVERHEAD COST FROM BEING EXCESSIVE

Improving Drain Tile Resistance to Alkali Conditions

By Dalton G. Miller

THIS PAPER is based on results of observations of experimental specimens subjected to artificial sulphate solutions in the laboratory, and to the behavior of specimens installed under natural field exposure conditions in Minnesota and North Dakota and in Medicine Lake, South Dakota. Medicine Lake is a 300 or 400-acre body of clear water, some 30 or 40 ft in extreme depth, lying 18 mi northwest of Watertown. The salt content ordinarily averages about 5 per cent with an extreme around 12 per cent during 1934 and 1935. About two-thirds of the salts are magnesium sulphate and one-fourth sodium sulphate. For this work over sixty thousand 2x4-in cement concrete and cement mortar cylinders, 4000 specially made concrete drain tile, and numerous miscellaneous specimens, have been made. The experiments, while primarily planned to aid in the general improvement of farm drain tile, have a wide application, in many of their aspects, to the use of concrete culverts, water and sewer pipe, irrigation structures, foundations, and all other types of concrete construction that, in service, must resist the action of soils or waters rich in sulphates.

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers, at Estes Park, Colo., June 1936. Approved as Journal Series Paper No. 1434 of the University of Minnesota. It represents results of experiments at University Farm, St. Paul, Minnesota, in the drain tile laboratory operated under a cooperative agreement of the Department of Agriculture of the University of Minnesota; the Division of Drainage and Waters of the Department of Conservation, State of Minnesota; and the USDA Bureau of Agricultural Engineering.

Author: Senior drainage engineer, USDA Bureau of Agricultural Engineering. Mem. ASAE.

Standard portland cements from different manufacturing plants may differ greatly in sulphate resistance. The range of resistance may be as much as one thousand per cent. In other words, concrete made of a cement of the highest resistance will last ten times as long as a cement of the lowest resistance, type of concrete and exposure conditions being identical. Actually there may even be a much greater difference than one thousand per cent where the condition of exposure is only moderately severe. In such a case the concrete made of a cement of high resistance may completely resist attack whereas that made of a cement of low resistance may fail within a relatively short period of time. It is not yet fully understood why such is the case, although much time and thought has been spent by cement chemists and engineers covering a period of many years. Particularly during the past decade, numerous agencies have contributed much of value on the subject as the result of several very comprehensive research programs. Also the past decade has been marked by the increased use of special high early strength cements, and cements of low heat of hydration, such as was used in Boulder Dam and have been and are being used in other massive structures. The general effect of all these studies has been a very great stimulation of interest in the chemistry of portland cement with the consequence that, more and more, specifications have been written during recent years stipulating that cements for particu-

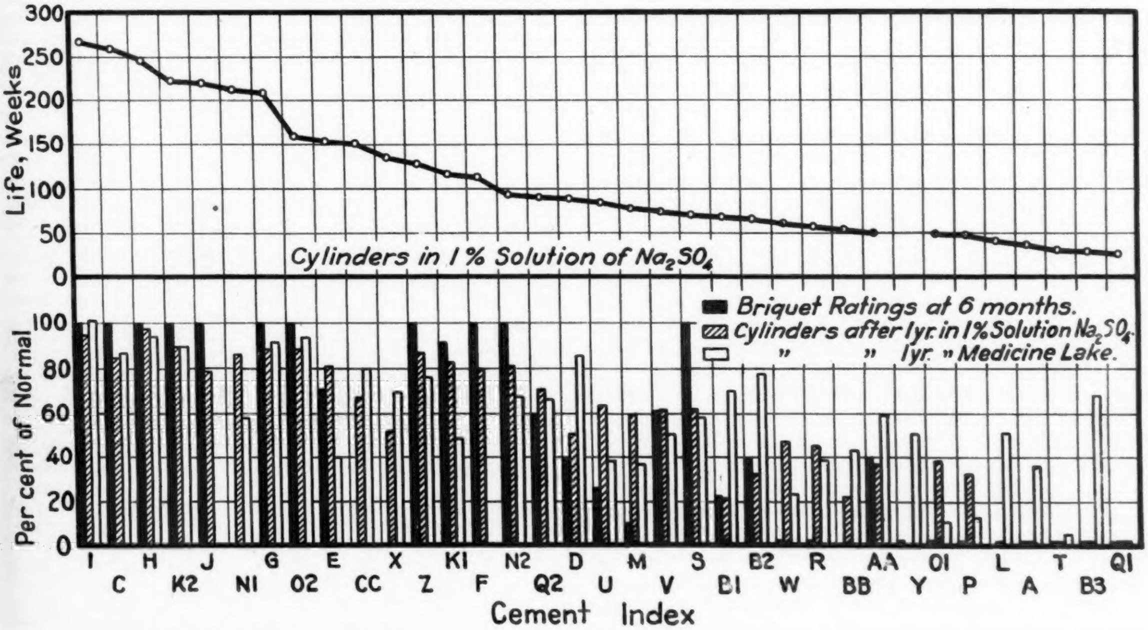


FIG. 1 RESISTANCE TO THE ACTION OF SULPHATE WATERS OF STANDARD PORTLAND CEMENTS FROM 35 DIFFERENT PLANTS AS DETERMINED BY DIFFERENT CONDITIONS OF EXPOSURE. NOTE PARTICULARLY THE GENERAL RELIABILITY OF THE BRIQUET RATINGS BY VISUAL APPEARANCES AS COMPARED WITH THE CHANGE OF VOLUME AND COMPRESSION TESTS OF THE CYLINDERS

lar jobs meet certain chemical requirements. Naturally the demands upon the manufacturers of portland cement have been very great if they were to keep abreast of the current trend. All of which has been disquieting, but withal has had a wholesome effect upon the whole cement industry in that the various manufacturers have closely studied and modified their individual products wherever it appeared that the change would result in improvement.

In order to extend the knowledge of the sulphate resistance of present day commercial portland cements and to determine the actual practical advantages of stipulating that portland cements to be used in concrete to be exposed to sulphate attack be made in accordance with some of the various more recent specifications, last year the work at the University of Minnesota was extended until there are now under observation 157 portland cements from 103 mills. Each cement is being tested under four, and many under five, distinct exposure conditions. Results of these tests have been completed for 35 cements and are compared graphically in Fig. 1. Study of Fig. 1 shows that those cements which best resisted sulphate action under one condition of exposure ordinarily were resistant to action under the other conditions. Based on numerous repeat tests, the assumption that resistance of a cement is a characteristic fully as constant as any other property seems justified.

To eliminate cements very low in resistance from consideration for concrete that is to be exposed to the action of sodium sulphate or magnesium sulphate, the following test routine is suggested:

One-half of each of the three briquets used in the standard 7-day tensile test should be stored in a 5 per cent solution of sodium sulphate and the companion halves in a 5 per cent solution of magnesium sulphate. To make these 5 per cent solutions, on the basis of anhydrous salts, requires 15 oz of room-dry salt per gallon of water. Not more than 15 briquet halves should be stored in each gallon of solution, which should be renewed completely every 4 weeks. It is desirable that the temperature of the solutions be maintained as near 70 deg F as practicable. Earthenware jars, covered to reduce evaporation, are satisfactory and convenient containers.

Briquets made of highly resistant cements and stored under the conditions prescribed, will show little or no visible action in either solution in less than 16 weeks, excepting perhaps a slight rounding of the edges. Briquets made of cements very low in resistance, when subjected to this test, will have almost completely disintegrated in 16 weeks. The value of the test as outlined will be greatly increased if briquets made of cements from several mills are included in order to give a basis for directly comparing behavior. If this is done, the failure of any cement falling well below average will be more convincing.

The feasibility of speeding up this 16-week test by increasing the strength of the solution, by keeping the solution at higher temperature, by using leaner mixes, and in numerous other ways, has been tried without satisfactorily consistent results. A more accelerated test of equal reliability is greatly to be desired, but cannot yet be offered.

It was learned from experiments begun in 1922 that concrete cured in steam over water boiling at atmospheric pressure displayed remarkable resistance in the laboratory to solutions of magnesium and sodium sulphate. After nearly 14 years, some of these cylinders are still under observation and their condition as indicated by volume changes measured by change of lengths are shown in Fig. 2. For each of the groups, resistance to sulphate action was in the same order as duration of time in steam, whereas for the water-cured groups the resistance was in the order of time in air.

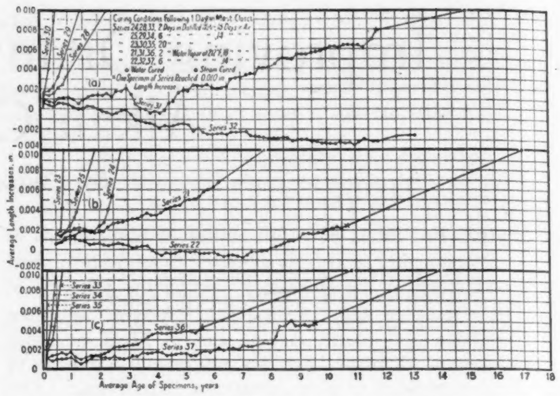


FIG. 2. INCREASE IN LENGTH WITH AGE OF 2-BY-4-IN PORTLAND CEMENT MORTAR AND CONCRETE CYLINDERS, 1:3 MIX, STORED IN SULPHATE SOLUTIONS; A, CONCRETE CYLINDERS IN 1 PER CENT SODIUM SULPHATE; B, CONCRETE CYLINDERS IN 1 PER CENT MAGNESIUM SULPHATE; C, OTTAWA SAND MORTAR CYLINDERS IN 1 PER CENT MAGNESIUM SULPHATE. CURING CONDITIONS FOLLOWING ONE DAY IN MOIST CLOSET WERE: FOR SERIES 24, 28, AND 33, 2 DAYS IN DISTILLED WATER AND 18 DAYS IN AIR; FOR SERIES 25, 29, AND 34, 6 DAYS IN DISTILLED WATER AND 14 DAYS IN AIR; FOR SERIES 23, 30, AND 35, 20 DAYS IN DISTILLED WATER; FOR SERIES 21, 31, AND 36, 2 DAYS IN WATER VAPOR AT 212 DEG, AND 18 DAYS IN AIR; FOR SERIES 22, 32, AND 37, 6 DAYS IN WATER VAPOR AT 212 DEG AND 14 DAYS IN AIR. A LENGTH INCREASE OF 0.01 IN INDICATES 60 TO 70 PER CENT LOSS IN COMPRESSIVE STRENGTH. EACH POINT IS THE AVERAGE FOR 5 OR 10 CYLINDERS MADE ON FIVE DAYS

It will be noted that, while steam curing at 212 deg up to 6 days did not completely immunize the specimens to the action of either 1 per cent magnesium sulphate or 1 per cent sodium sulphate solutions, the effect of steam curing was

TABLE 1. EFFECT ON SULPHATE RESISTANCE OF CURING PORTLAND CEMENT CONCRETE AT TEMPERATURES BETWEEN 212 AND 350 DEG FOR TIME PERIODS INDICATED

In each case the upper value is compressive strength per square inch of cylinders stored in tap water in the laboratory for 5 years, the second value is the strength of cylinders after 5 years in Medicine Lake, and the value in parentheses is the strength ratio of Medicine Lake cylinders to those from the tap water. Each result is the average for five 2x4-in cylinders. Mix 1:3, w/c 0.62.

Hours steam cured	Temperature of steam 212 deg F	230 deg F	260 deg F	285 deg F	315 deg F	350 deg F
¾	6300	6060	6760	6790	6790	5930
	0	4640	5540	6650	6220	5950
	(0)	(77)	(82)	(98)	(92)	(100)
1½	7330	6190	6930	6680	6660	7170
	0	4870	5970	6660	6140	6390
	(0)	(79)	(86)	(100)	(92)	(89)
3	6550	7090	6190	7020	6630	7110
	0	5660	6100	6580	6770	6970
	(0)	(80)	(99)	(94)	(102)	(98)
6	6920	6790	6490	7320	6530	5700
	5150	5820	6350	6900	6320	5660
	(74)	(86)	(98)	(94)	(97)	(99)
12	7070	6760	7010	6310	4450	4390
	5620	6240	6550	5330	4560	4730
	(79)	(92)	(93)	(84)	(102)	(108)
24	6850	6470	5620	5310	3980	5210
	6100	6210	5490	5160	4460	4590
	(89)	(96)	(98)	(97)	(112)	(88)
48	6580	6270	5060	3940	3670	5470
	5960	6260	5090	4330	4430	5850
	(91)	(100)	(101)	(110)	(121)	(107)
96	6950	5660	4350	4600	4400	5850
	6200	6010	4180	5450	4600	5730
	(89)	(106)	(96)	(118)	(105)	(98)
192	5500	4080	4480	4480	3880	4970
	5520	4060	4650	5760	5200	5260
	(100)	(100)	(104)	(129)	(134)	(106)

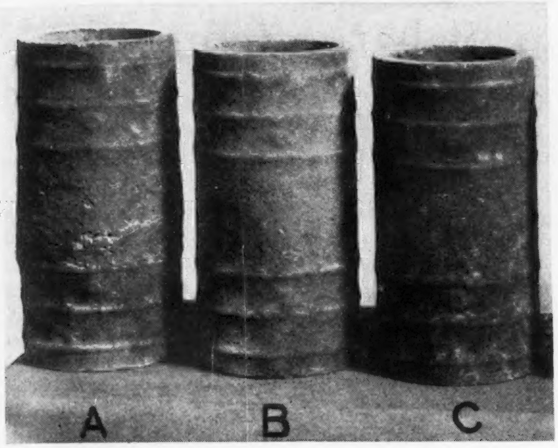


FIG. 3. FIVE-IN CONCRETE DRAIN TILE AFTER 1 YEAR EXPOSURE IN THE ALKALI WATER OF MEDICINE LAKE. TILE A IS THE CHECK TILE AND CONTAINED NO CALCIUM CHLORIDE. TILE B AND TILE C CONTAINED 2 AND 4 PER CENT CALCIUM CHLORIDE, RESPECTIVELY. ALL TILE WERE CURED 48 HOURS AT 130 DEG. AVERAGE STRENGTH TESTS OF 5 TILE OF EACH GROUP AFTER 1 YEAR IN MEDICINE LAKE WERE AS FOLLOWS: TILE A, 630 LBS.; TILE B, 1615 LBS.; TILE C, 1880 LBS.

greatly to increase the life of the specimens over that of the directly comparable water and air-cured specimens which made the best showing in each group. As examples of the effect of steam-curing two days, the life of the cylinders of series 31 was 650 per cent that of series 28, series 21 was 300 per cent that of series 24, and series 36 had a life over 1500 per cent that of series 33. The life of the cylinders steam-cured 6 days made even more favorable showings, as the cylinders of series 32 still show no volume increase after nearly 14 years exposure, while the cylinders of series 22 had a life over 600 per cent that of series 24, and the life of the cylinders of series 37 was 2,000 per cent that of series 33.

Following the earlier laboratory work there were made for exposure to the water of Medicine Lake a total of 6,525 cylinders in 145 series. In this group, cylinders were cured in water vapor at temperatures of 100, 155, 190, 212, 230, 260, 285, 315, and 350 deg for periods, at most temperatures, ranging from 45 min to 8 days. Results of 5-year tests of cylinders cured at temperatures upward from 212 deg for various time periods upward to 8 days are shown in Table 1. No data are presented to show results where curing temperatures were lower than that of boiling water for the reason that it has been found by many tests that curing in water vapor between 100 and 190-deg does not increase resistance. On the contrary, in some cases decreased resistance follows.

The data of Table 1 indicate a very definite relation between curing temperatures and duration of the curing period. While not exact, it appears from the table that for equal effectiveness for time periods up to 8 days, the correlation is about as shown in Table 2 for the various temperatures.

TABLE 2. Equally effective curing periods at indicated steam temperatures for concrete to be exposed to attack of sulphate waters

Curing period	Temperature
8 days	212 deg F
4 days	230 " "
2 days	260 " "
1 day	285 " "
12 hours	315 " "
6 hours	350 " "

Mixing special ingredients with portland cement concrete to increase resistance to sulphate attack, although advocated and practiced, has been from the first a matter of extended controversy. That early opinions regarding admixtures were divergent is not difficult to comprehend, for, as already mentioned, there is a great range in the resistance of portland cements from different mills as well as decided variations in the resistance of concrete due solely to variations of curing conditions. Therefore, these factors had to be carefully weighed in comparing the behavior of concretes with and without admixtures, otherwise the results might be so contradictory as to be wholly valueless, or at best very misleading. It is not the intention here to discuss the effect of admixtures generally on resistance of concrete to sulphate attack, but only to touch on results with calcium chloride, particularly in conjunction with low-temperature steam curing of 100 to 155 deg, as ordinarily used at many tile plants of the upper Mississippi Valley.

The experiments with calcium chloride here reported cover its use in cylinders and in drain tile. The cylinders were exposed to the action of sodium sulphate in the laboratory, and to the waters of Medicine Lake. The drain tile were made and cured at a commercial tile plant and exposed in Medicine Lake. For the cylinders, calcium chloride equivalent in weight to 4 and 8 per cent of the cement was dissolved in the mixing water. Four per cent was added to cylinders stored in the laboratory in 1 per cent solutions of sodium sulphate, while 4 and 8 per cent were used in cylinders exposed in Medicine Lake, some cured normally and some cured in water vapor at 155 deg. The sulphate resistance of cylinders was increased by the calcium chloride in all cases except one Medicine Lake series with 4 per cent and without air hardening. Cylinders containing 4 and 8 per cent calcium chloride when cured at 155 deg gave the high strength ratios of 84 and 82 per cent, respectively, at five years. This is an excellent showing for Medicine Lake exposure conditions. Incidently, 4 per cent calcium chloride had slight effect on the strength of the cylinders stored in tap water up to 5 years, but 8 per cent reduced the strengths at all ages, the average reduction being in excess of 20 per cent. Therefore, 4 per cent is about the maximum desirable limit for the cements used in these experiments, and even this might be somewhat in excess of what would be desirable for other cements.

Two and 4 per cent calcium chloride used in commercially-made 5-in drain tile cured in steam at 130 deg increased the resistance of the tile to the water of Medicine Lake as illustrated by the views of Fig. 3. These views are after exposure for 1 year in Medicine Lake. Additions of 2 per cent calcium chloride need not increase the cost of 5-in drain tile, selling at 6 cents per foot, by more than two-tenths of a cent. Inasmuch as many concrete tile plants already use live steam at 100 to 155 deg in curing their products, this method is admirably suitable of application. However, there still remains to be done considerable work to determine the most effective and practicable curing temperatures, time periods, and the response using different cements. Three cements were used in these tests, all of them being low in natural resistance. Determination as to whether or not the same relative improvement in resistance will follow the use of calcium chloride with cements of high natural resistance must wait the completion of tests now under way. In fact, it is well to add that the use of calcium chloride as here reported is still experimental and supporting data are necessary before definite conclusions can be drawn as to the extent and limitations of its value as an admixture for increasing resistance of concrete to sulphate attack. The tests to date, *(Continued on page 544)*

Energy Consumption of Large Churns

By Jefferson B. Rodgers

IF CREAMERY equipment is to be managed efficiently and economically, the electric power requirements of each piece of equipment must be known. This is particularly true if the various power-consuming operations are to be distributed throughout the twenty-four hours in order to secure a more uniform power demand and lower power costs. A recent study conducted by the departments of agricultural engineering and dairy husbandry of the University of Idaho, in cooperation with the managements of two large representative Idaho creameries, resulted in the collection of valuable data on the electric power requirements of creamery equipment.

One of the most interesting and important pieces of equipment studied was the churn. The energy and power demand at any time during a churning cycle was determined by measuring the input to the churn drive motor by means of a graphic watthour demand meter. A typical demand meter record of one representative day's churning of four churnings per churn is shown in Fig 1. The power requirements of two competitive makes of churns were studied. For convenience in designation we shall refer to the two makes of churns as "X" and "Y" and the two creameries where the churns were in use as "A" and "B". The capacity of the X and Y churns was the same, 1,500 lb of butter, and both were driven by identical 7½ hp motors. The two churns differed principally in the physical dimensions of the barrels. The X churn was a large-diameter churn with a short barrel and the Y churn was a small-diameter churn with a long barrel.

The energy consumption and operating data of the two makes of churns are shown in Table 1. A study of this table reveals striking differences in power requirements for the churns per 100 lb of butter churned. Creamery B has an X and a Y churn, both managed by the same butter maker. It will be noted from Table 1 that for day-old cream the X churn required 0.385 kwh (kilowatt-hours) and the Y churn 0.269 kwh per 100 lb of butter churned, a difference of 0.116 kwh, or 43.2 per cent more power was required by the X churn than by the Y churn. For fresh cream the percentage difference was only slightly less, being 40 per cent instead of 43.2 per cent. It should be emphasized again that the principal difference between the two churns was a difference in barrel dimensions.

Author: Assistant agricultural engineer, University of Idaho. Mem. ASAE.

TABLE 1. Power Requirements for Churning Per 100 Pounds of Butter Churned

Creamery	Churn model	Number of churnings Day-old cream[1]	Number of churnings Fresh cream[2]	Total butter churned, lb	Churn capacity, lb	Capacity at which churn was operated, per cent	Average kwh per 100 lb butter churned[3]	Kwh to operate while being washed
A	X	19		25,136	1,500	88.00	0.442	3.160
B	X	12		16,765	1,500	93.14	0.385	
B	X		2	2,884	1,500	96.13	0.469	0.855
B	Y	15		22,307	1,500	99.14	0.269	
B	Y		5	7,349	1,500	97.99	0.335	0.672

[1]Average churning temperature, 50 to 55 deg (Fahrenheit)
[2]Average churning temperature, 40 to 44 deg
[3]Does not include power to operate churn while it is being washed at the end of the day's churning.

More power was required to churn fresh cream than day-old cream due, in part, to the fact that the viscosity of the fresh cream was higher than that of day-old cream, as the former was churned at a temperature of 40 to 45 deg, and the latter at 50 to 55 deg. It was found that the X and Y churns at creamery B required 21.8 and 24.5 per cent more power, respectively, to churn fresh cream than day-old cream.

Table 1 shows that the X churn at creamery A required 0.442 kwh per 100 lb of butter churned as compared with 0.385 kwh for the X churn at creamery B, a difference of 0.057 kwh, or 14.8 per cent more power required at creamery A than at creamery B. There are several factors contributing to this difference, one being the capacity at which the churns were operated.

Another fact noted in Table 1 is the difference in the power required for the churn washing operation. The total amount of power required for washing the churn at creamery A was larger than at creamery B, indicating that the washing operation continued for a longer period of time. This statement is also borne out by noting the lines under (3) in Fig 1.

VARIATION IN POWER DEMAND DURING THE CHURNING CYCLE

An interesting fact noted in connection with the power requirements of the churn was the variation in power demand during a churning cycle. The variation by 15-min intervals was graphically recorded by the demand meter and the results of one typical day's churning of four churnings per churn is shown in Fig 1; the churnings progress from left to right. The series of three or four lines denoted by (1) in Fig 1 represent the power demand during each 15-min interval of a churning cycle up to the point of working the butter. The difference between (1) and (4) is that the former represents the power required to churn day-old cream, while the latter is the power required for churning fresh cream. The lines in Fig 1 denoted by (2) represent the power required to work the butter after the buttermilk had been drained off. The lines under (3) represent the power required to wash the churn at the end of the day's churning.

It will be noted that as the churning progressed and

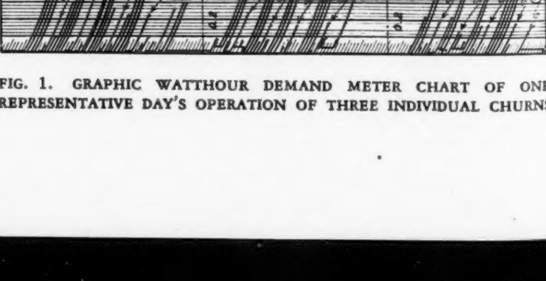


FIG. 1. GRAPHIC WATTHOUR DEMAND METER CHART OF ONE REPRESENTATIVE DAY'S OPERATION OF THREE INDIVIDUAL CHURNS

the viscosity of the cream became greater, more power was required to drive the churn. The point of maximum power demand was reached just as and shortly after the butter broke. The power requirements during this period in the churning cycle were obtained by observing the meter disk. As the granules of butter collected into a larger and larger mass of butter, each succeeding uplift of the shelf in the churn required a heavier surge of power than the one preceding; this was indicated by the spinning of the meter disk. As the shelf approached the top of its travel and started down, the meter disk was observed to slow down, stop, and for a brief instant rotate in the opposite direction, thus indicating that for a brief interval of time during each revolution of the barrel at this particular stage in the churning cycle the motor was being driven above synchronous speed, causing it to act as an induction generator and to generate a small amount of electricity. The power reversal just described was noted only for the X churn; the Y churn did not cause a power reversal. However, a power surge of smaller magnitude than that noted in the X churn was associated with each uplift of the shelf during the latter part of the churning cycle.

A Log Sweet Potato Storage House

By C. J. Hutchinson

IN MANY sections of the country, particularly in the South, logs and poles can be employed advantageously in the construction of potato curing and storage houses. Where timber is plentiful, this method of construction permits the use of local materials and labor, thus saving practically the entire cash cost of construction, except for a few nails.

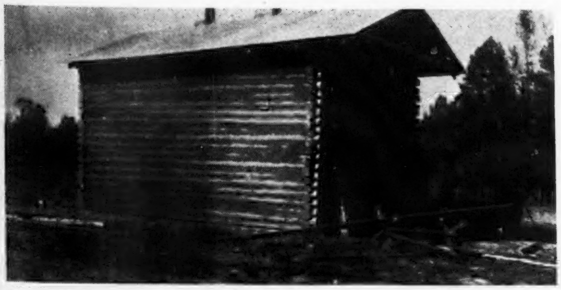
In Louisiana several hundred pole and log potato curing houses have been constructed at costs ranging from practically nothing to $18 or $20 each, and each house has satisfactorily cured and stored from 150 to 400 bu of sweet potatoes.

Practically any tree may be used for this purpose, but generally pine trees from 5 to 8 in in diameter are most commonly used in the South. Sixty to eighty poles, 14 and 16 ft long, will construct a building that will store 250 to 300 bu of potatoes. When constructing a building of this type, select trees as near the same size as practical, cut them into lengths desired, peel the bark and allow to dry before erecting the building.

A properly built potato curing house must provide for thorough drying and uniform temperature. It must be constructed so that it can be thoroughly ventilated when necessary and yet afford necessary protection against cold weather. Generally the walls are started from the ground line, using a larger log for a foundation, but in this case a well-drained location must be obtained so that no ground moisture comes up inside the building. A slatted floor 18 in from the ground, which also may be made of small poles covered with a thin layer of straw, should be provided so as to allow a free circulation of air from ventilators in each corner of the building, up through the potatoes and out at the vents through the roof. A slatted partition, 6 in from the building walls, prevents the potatoes from coming in contact with the wall and assures a more complete circulation of air. A small stove, or oftentimes a lantern hung in the building, will furnish enough heat to keep the temperature high enough and cause sufficient circulation to properly take out the excess moisture during the curing period.

A contribution of the ASAE Committee on Natural Building Materials.

Author: Extension agricultural engineer, Louisiana State University. Mem. ASAE.



A LOG SWEET POTATO CURING HOUSE UNDER CONSTRUCTION FOR ONE FARM IN LOUISIANA

The cracks between the logs should be chinked with mud and straw and made perfectly airtight. To accomplish this, it is often necessary to let the first application of mud and straw dry. Then a second application of a thick paste made of clay and water may be applied to fill all cracks and give a smooth finish both on the inside and outside of the building.

When lack of drainage will not permit a ground floor, it is necessary to put the building on piers. In this case, it is advisable to use a double floor to insure the proper temperature control. In this case the vents may come through the floor in each corner of room instead of the walls, but a slatted floor, 6 in high, should be provided.

Where potatoes are placed in the house in bulk, it is advisable to put in one or more tiers of deep, slatted shelves to place the potatoes on, instead of piling them too deep on the bottom floor. They will dry out much better if the layers are not over 18 to 24 in deep.

Even with a properly constructed house, there are certain principles to be observed in the proper curing of sweet potatoes. A temperature of 80 to 85 deg F should be maintained, with plenty of ventilation for the first ten days or two weeks of the curing period. Ventilation is essential to take off the excess moisture. When the potatoes are thoroughly cured the temperature may be gradually reduced to about 55 deg and kept as near this point as possible during the remainder of the storage period. When the temperature in the house goes down to 48 deg, heat should be applied to bring the temperature back to 55 deg. If it goes above this point, ventilators may be opened, and then closed when the temperature comes back to normal. In mild weather the ventilators in the roof may be partially opened to cause some circulation of air, but they should remain closed in cloudy or cold weather.

Air Conditioned Poultry Brooder Houses

By John E. Nicholas and E. W. Callenbach

THE chick brooding season usually begins in the early spring. For the past three years, at The Pennsylvania State College, an experimental brooding season starting in November or December has been used in a study of environmental conditions as supplied by representative types of brooders and brooding systems.

During the winter of 1935-36 it became necessary in a new phase of the study, to maintain definite brooder house temperatures and humidities. In order to accomplish this purpose four brooder houses were completely remodeled and equipped with suitable devices for temperature and humidity control.

Brooder Houses and Insulation. Four standard 12x16 ft Penn State brooder houses were used. For convenience these will be referred to as houses 19, 20, 21, and 22. The four houses were insulated[1], all curtain and window openings being eliminated. House 19 was insulated with mineral wool; house 20 with processed vermiculite; and houses 21 and 22 with Celotex. Double doors were used, outside doors being the original standard 3 by 6-ft 6-in batten doors.

The 6-in ceiling spaces and the 4-in wall spaces in houses 19 and 20 were filled with insulating material held in place by ⅜-in wall board. The inside doors were constructed with 4 in of the respective insulation held in place by the wall board.

In houses 21 and 22, the walls, ceilings, and inside doors were lined with two thicknesses of 1-in celotex.

The floors in all houses were covered with 2 in of planer shavings. Fig. 1 illustrates in cross section the insulation of walls, floors, and ceilings in the experimental houses.

Paper presented before the North Atlantic Section of the American Society of Agricultural Engineers at Skytop, Pa., October 15, 1936. Authorized as Paper No. 740 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

Authors: Respectively professor of agricultural engineering, (Mem. ASAE) and associate professor of poultry husbandry, The Pennsylvania State College.

[1] The insulating materials used in the brooder houses were furnished through the courtesy of Standard Lime and Stone Co., Baltimore, Md.; F. E. Schundler and Co., Long Island, N. Y.; and Celotex Corporation, Chicago, Ill.

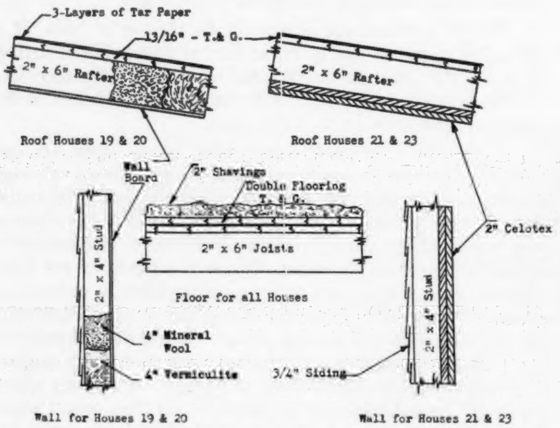


FIG. 1 CROSS SECTION OF THE WALLS, FLOORS, AND CEILINGS IN THE FOUR EXPERIMENTAL BROODER HOUSES. (THE BUILT-UP-ROOF IS MADE OF SLATER'S FELT AND HOT ASPHALT)

Experimental Equipment. Two of the brooder houses were operated as "hot" pens, the other two being "cold". In the former, the temperature to be maintained was 75 deg (Fahrenheit) taken 2 in above the floor at a point 28 in from the edge of the brooder. The allowed temperature variation was to be approximately ± 2.5 deg. The two "cold" houses were to be maintained as near to 35 deg as the existing outside weather conditions would allow. Refrigeration equipment was not available to provide the low temperature desired during the warmer weather of brooding season.

All equipment was operated electrically. The houses were provided with sufficient insulation and heat to permit six air changes per hour and maintain a 75 deg temperature differential in zero weather. Two electric heaters equipped with fans, having a heating capacity of 1320 watts each, were used in the "hot" houses. One heater was placed in each "cold" house and set to operate when the house temperature dropped below 35 deg. Fig. 2 shows one of the fan heaters with its sensitive electronic temperature control. Fig. 3 is a diagrammatic description of this temperature control.

In the two experimental series, 125 sexed chicks have been used in each of the four brooder houses. The houses and equipment as described were used for the first series from November 27, 1935 to February 20, 1936. In this series, houses 19 and 22 were "hot"; 20 and 21 were "cold". In the second series from February 26 to May 20, 1936, houses 19 and 20 were "hot", while 21 and 22 were "cold". Since humidity was found to be a variable factor in the first series, humidification equipment was provided for series II. A Gilbert humidifier (Fig. 4) was used in each of the "hot" houses in this series. The relative humidity in each "hot" house was adjusted to approximately the percentage obtained naturally in the respective "cold" house. Fig. 4 shows the humidifier located directly below one of the fan heaters. This arrangement aided materially in obtaining uniform distribution of water vapor throughout the brooder house. The pan on the left of the humidifier was an additional water reservoir connected directly to the humidifier water supply by flexible rubber tubing.

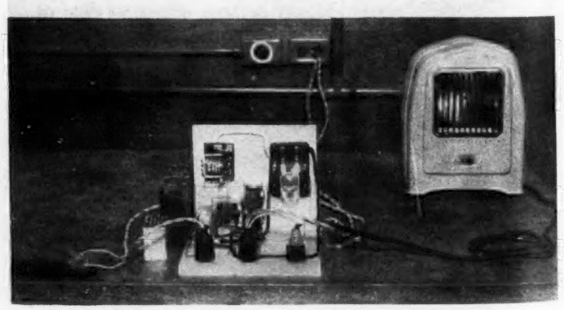


FIG. 2 ASSEMBLED PARTS OF THE ELECTRONIC TEMPERATURE CONTROL MOUNTED ON A RIGID SUPPORT, AND ONE OF THE ELECTRIC HEATERS USED IN THE EXPERIMENT

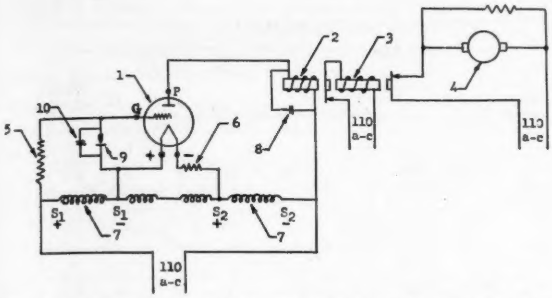


FIG. 3 WIRING DIAGRAM FOR THE TEMPERATURE CONTROL AND ELECTRIC HEATER SHOWN IN FIG. 2: 1, 45 VACUUM TUBE; 2, VACUUM TUBE RELAY 2 AMP ON CONTACT; 5 MA ON COIL D-C; 3, POWER RELAY (CONTACTS 120 VOLTS A-C, 30 AMP); 4, 1320-WATT HEATER AND FAN COMBINED; 5, ½ MEG RESISTOR; 6, 6-OHM RESISTANCE; 7, S_1 AND S_2 FILAMENT TRANSFORMERS (2.5-VOLT); 8, CONDENSER (8 MFD); 9, BIMETALIC THERMOSTATIC STRIP; 10, CONDENSER (0.02 MFG)

Each house had the following additional equipment: (1) A reliable insulated electric brooder[2] having a 56-in canopy; (2) an Ilgette (9-in diameter) exhaust fan for ventilation (see Fig. 5); (3) feeding, watering, and miscellaneous housing equipment usual to chick rearing; (4) a 40-watt bulb for daytime lighting and a 10-watt bulb for night illumination.

Heat Transmission Coefficients. The heat losses from the houses by transmission through the walls, roof, and floor were determined by the standard formula:

$$U = \frac{1}{1/f_i + 1/f_o + 1/a + x_1/k_1 + x_2/k_2 + x_3/k_3 + \ldots}$$

where U = overall coefficient of heat transmission expressed in Btu transmitted in one hour per square foot of floor, roof, or ceiling for a difference in temperature of 1 deg (Fahrenheit) between the inside and outside air

k = thermal conductivity of a homogenous material 1 in thick

f_i = inside surface conductance

f_o = outside surface conductance

a = thermal conductance of an air space

x_1, x_2, etc. = the thickness in inches of building materials used.

The surface conductance for the floors $f_i = f_o = 1.65$

The outside surface conductance for roof and walls $f_o = 6.5$.

The inside surface conductance for roof and walls $f_i = 1.65$.

The thermal conductivity, k, and the computed values of U for the insulating materials used in the four houses are shown in Table 1. The following calculations preceding the table demonstrate the application of the formula in determining the U values:

Calculations for Houses 19 and 20

Insulated with mineral wool and processed vermiculite

$$\textit{Roof}\ U = \frac{1}{1/f_1 + 1/f_o + 1/a + x_1/k_1 + x_2/k_2 + \ldots\ldots}$$

$$f_1 = 1.65 \qquad x_1 = 5.625$$
$$f_1 = 6.5 \qquad k_1 = 0.30$$

For built-up-roof and tongued and grooved.

Assume $x_2 = 1$ and $k_2 = 1$.

(Roof deck coefficient = $x_2/k_2 = 1/1$)

$$\text{Therefore } U = \frac{1}{1/1.65 + 1/6.5 + 5.625/.3 + 1/1} = 0.049$$

$$\textit{Walls}\quad U = \frac{1}{1/1.65 + 1/6.5 + 3.625/.3 + .75/1} = 0.074$$

$$\textit{Floor}\quad U = \frac{1}{1/1.65 + 1/1.65 + 1.625/1 + 2/.45}$$

= 0.137, and is the *same* for all houses.

(NOTE: The insulating value of the ⅜-in wallboard used for inside lining was ignored.)

Calculations for Houses 21 and 22

Insulated with two thicknesses of one-inch celotex on walls and ceiling

$$\textit{Roof}\ U = \frac{1}{1/f_1 + 1/f_o + 1/a + x_1/k_1 + x_2/k_2 + x_3/k_3 + \ldots}$$

$$f_1 = 1.65 \qquad a = 1.1 \qquad k_1 = k_2 = 0.34$$
$$f_o = 6.5 \qquad x_1 = x_2 = 1$$

For built-up-roof and tongued and grooved.

Assume $x_3 = 1$ and $k_3 = 1$

(Roof deck coefficient = 1/1)

$$\text{Therefore, } U = \frac{1}{1/1.65 + 1/6.5 + 1/1.1 + 2/.34 + 1/1} = 0.117$$

$$\textit{Walls}\quad U = \frac{1}{1/f_1 + 1/f_o + 1/a + x_1/k_1 + x_2/k_2} = 0.121$$

TABLE 1.—Calculated values of U for the four houses based on commercial value of k

House No.	Type of insulation	Conductivity k	Overall coefficient, U for Roof	Walls	Floor	Surface, sq ft Ceiling	Walls	Floor
19	Mineral wool	0.30	0.049	0.074	0.137	195	336	192
20	Vermiculite	0.30	0.049	0.074	0.137	195	336	192
21	Celotex	0.34	0.117	0.121	0.137	195	336	192
22	Celotex	0.34	0.117	0.121	0.137	195	336	192

TABLE 2. Energy consumption, average weekly temperature, and average relative humidities for

BROODER HOUSE No. 19 — SERIES I

No. of week	Energy used per week kwh	Weekly Average Temperatures, deg F: Brooder House Max.	Min.	Outside Air Max.	Min.	Psychrometer at 8:00 a.m. Wet bulb	Dry bulb	Av. relative humidity, per cent	Av. brooder temp. deg
1	233	77.0	67.1	40.3	27.8	56.8	79.3	21.0	104.0
2	251	79.8	70.4	39.8	23.8	59.3	80.7	25.4	101.0
3	234	79.6	75.1	32.6	29.6	62.0	81.3	31.4	95.0
4	272	78.1	72.0	26.9	11.7	58.9	79.6	29.2	91.0
5	280	76.6	72.9	22.6	7.0	62.6	83.6	29.2	87.8
6	200	76.4	73.0	36.0	24.5	64.2	80.7	40.2	82.0
7	163	76.2	69.0	37.8	26.2	62.8	77.5	48.2	
8	202	74.8	69.5	33.7	15.5	63.8	80.8	38.3	
9	302	74.4	69.5	13.0	6.1	61.2	80.8	30.9	
10	176	67.8	64.4	22.0	2.1	51.4	70.8	44.0	
11	37	53.5	51.1	21.0	5.0	44.2	54.5	60.5	
12	15	52.2	46.2	33.9	12.6	46.1	49.8	76.1	

[2]Brooder No. 3 as described by Nicholas and Callenbach in AGRICULTURAL ENGINEERING for September, 1935 (Vol. 16, No. 9, pp. 361-364).

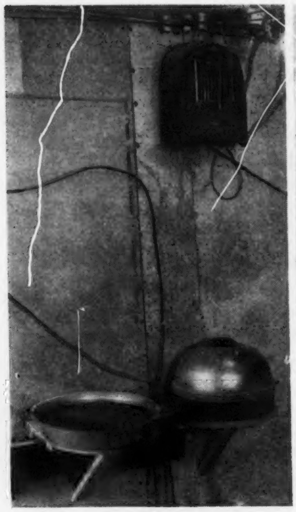


FIG. 4 (LEFT) THE GILBERT HUMIDIFIER, WITH SUPPLEMENTARY WATER RESERVOIR AND FAN HEATER ABOVE. FIG. 5 (ABOVE) ILGETTE EXHAUST FAN USED IN THESE EXPERIMENTS

Control Obtained. Tables 2 to 10, inclusive, present the results secured with the experimental equipment described above. In addition to data for temperature and humidity, the tables also show the electric energy consumption for each house, outside temperature conditions, and the temperatures at which the electric brooders were operated.

The brooder house temperatures were gradually adjusted during the tenth, eleventh and twelfth weeks so that at the expiration of this period environmental conditions in all

TABLE 3. Energy consumption, average weekly temperatures, and average relative humidities for
BROODER HOUSE No. 20 — SERIES I
Weekly Average Temperatures, deg F

No. of week	Energy used per week kwh	Brooder House Max.	Brooder House Min.	Outside Air Max.	Outside Air Min.	Psychrometer at 8:00 a.m. Wet bulb	Psychrometer at 8:00 a.m. Dry bulb	Av. relative humidity, per cent	Av. brooder temp. deg
1	72	47.5	39.4	40.3	27.8	38.4	43.8	61.1	104.8
2	77	48.4	40.0	39.8	23.8	40.5	45.4	67.0	99.8
3	63	51.2	45.1	32.6	29.6	43.0	47.2	70.4	95.7
4	47	40.5	31.1	26.9	11.7	33.4	36.1	76.4	91.1
5	35	40.1	26.4	22.6	7.0	32.2	34.1	84.8	88.5
6	16	54.0	44.7	36.0	24.5	45.8	50.2	72.1	83.1
7	11	55.0	47.5	37.8	26.2	47.8	51.7	75.8	77.2
8	11	53.2	42.7	33.7	15.5	44.2	48.0	85.1	73.5
9	11	43.5	30.1	13.0	6.1	34.4	36.0	79.4	67.4
10	12	48.1	36.8	22.0	2.1	41.8	43.5	76.0	62.0
11	10	51.4	38.0	21.0	5.0	42.0	45.4	75.6	
12	12	56.0	46.0	33.9	12.6	47.0	50.5	76.7	
13								53.0	

TABLE 4. Energy consumption, average weekly temperatures, and average relative humidities for
BROODER HOUSE No. 21 — SERIES I
Weekly Average Temperatures, deg F

No. of week	Energy used per week kwh	Brooder House Max.	Brooder House Min.	Outside Air Max.	Outside Air Min.	Psychrometer at 8:00 a.m. Wet bulb	Psychrometer at 8:00 a.m. Dry bulb	Av. relative humidity, per cent	Av. brooder temp. deg
1	65	43.0	41.5	40.3	27.8	38.8	45.1	57.4	105.0
2	73	48.8	41.4	39.8	23.8	40.4	46.4	63.8	100.4
3	63	51.8	45.1	32.6	29.6	43.7	48.4	68.4	96.0
4	52	42.8	33.7	26.9	11.7	34.5	37.0	79.0	91.8
5	36	39.7	25.2	22.6	7.0	32.8	34.4	84.0	88.1
6	20	55.4	46.8	36.0	24.5	48.0	51.2	78.7	83.0
7	15	54.2	47.5	37.8	26.2	47.2	51.4	73.1	77.0
8	12	51.5	40.5	33.7	15.5	42.1	45.8	74.5	71.0
9	15	42.8	29.2	13.0	6.1	34.4	37.7	82.5	69.0
10	11	48.1	38.1	22.0	2.1	40.8	43.8	78.4	61.8
11	11	52.2	41.8	21.0	5.0	38.7	41.1	80.5	59.0
12	10	54.1	42.5	33.9	12.6	40.5	43.4	69.1	
13								77.0	

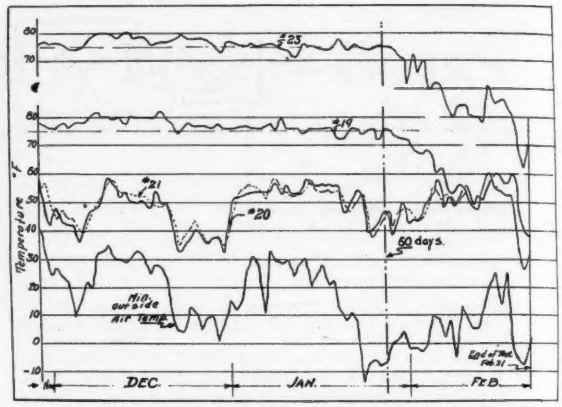


FIG. 6 TEMPERATURES IN THE "HOT" AND "COLD" BROODER HOUSES AND THE MINIMUM OUTSIDE AIR TEMPERATURE (SERIES I)

TABLE 5. Energy consumption, average weekly temperatures, and average relative humidities for
BROODER HOUSE No. 22 — SERIES I
Weekly Average Temperatures, deg F

No. of week	Energy used per week kwh	Brooder House Max.	Brooder House Min.	Outside Air Max.	Outside Air Min.	Psychrometer at 8:00 a.m. Wet bulb	Psychrometer at 8:00 a.m. Dry bulb	Av. relative humidity, per cent	Av. brooder temp. deg
1	248	75.7	71.0	40.3	27.8	60.0	82.1	24.5	103.4
2	259	78.0	73.5	39.8	23.8	61.2	81.7	29.1	100.7
3	215	78.4	74.0	32.6	29.6	62.4	80.8	34.2	95.7
4	309	77.8	72.2	26.9	11.7	59.7	78.5	31.0	90.2
5	287	76.0	66.8	22.6	7.0	59.8	78.5	31.8	85.4
6	221	75.5	74.2	36.0	24.5	64.1	79.0	44.1	84.0
7	179	73.7	69.8	37.8	26.2	64.0	76.5	49.8	
8	230	74.8	70.8	33.7	15.5	62.4	78.0	40.8	
9	354	74.7	74.0	13.0	6.1	60.7	80.0	31.0	
10	200	66.1	64.2	22.0	2.1	56.8	69.8	44.7	
11	81	53.4	52.5	21.0	5.0	46.5	52.7	74.0	
12	19	53.2	48.0	33.9	12.6	44.5	47.7	78.2	
13								81.0	

TABLE 6. Energy consumption, average weekly temperatures, and average relative humidities for
BROODER HOUSE No. 19 — SERIES II
Weekly Average Temperatures, deg F

No. of week	Energy used per week kwh	Brooder House Max.	Brooder House Min.	Outside Air Max.	Outside Air Min.	Psychrometer at 8:00 a.m. Wet bulb	Psychrometer at 8:00 a.m. Dry bulb	Av. relative humidity, per cent	Av. brooder temp. deg
1	231	79.5	77.0	42.4	23.9	72.0	84.0	50.0	103.7
2	189	78.7	76.6	45.1	26.1	70.4	83.4	52.1	95.2
3	198	79.7	76.6	49.4	30.9	73.7	84.4	60.3	87.2
4	220	78.8	76.1	53.9	34.9	71.4	84.5	52.7	83.8
5	142	76.8	75.0	62.7	36.4	66.8	80.3	48.4	85.4
6	224	79.0	74.6	46.7	29.7	70.7	83.3	53.1	80.6
7	217	79.1	75.1	53.0	35.0	72.4	82.7	61.4	80.0
8	211	78.0	75.4	54.7	32.9	68.0	79.3	56.3	
9	132	78.4	76.7	63.9	34.3	69.7	80.3	59.0	
10	38	73.4	63.7	74.6	49.6	63.7	71.6	64.8	
11	17	78.6	74.0	86.0	56.0	71.0	77.8	69.1	
12	20	72.4	59.8	72.9	44.9	59.8	67.7	63.2	

TABLE 7. Energy consumption, average weekly temperatures, and average relative humidities for
BROODER HOUSE No. 20 — SERIES II
Weekly Average Temperatures, deg F

No. of week	Energy used per week kwh	Brooder House Max.	Brooder House Min.	Outside Air Max.	Outside Air Min.	Psychrometer at 8:00 a.m. Wet bulb	Psychrometer at 8:00 a.m. Dry bulb	Av. relative humidity, per cent	Av. brooder temp. deg
1	285	81.9	69.7	42.4	23.9	68.9	82.1	43.1	103.6
2	275	86.1	76.1	45.1	26.1	69.1	83.1	48.5	98.4
3	269	79.0	73.8	49.4	30.9	70.7	83.5	52.7	87.8
4	298	83.4	73.5	53.9	34.9	69.5	84.7	46.4	82.8
5	184	79.7	76.5	62.7	36.4	67.5	81.1	48.8	82.8
6	270	78.7	72.2	46.7	29.7	63.7	76.0	49.8	80.0
7	199	80.8	70.8	53.0	35.0	65.8	77.1	53.5	81.0
8	214	78.7	72.7	54.7	32.9	66.2	78.6	51.4	
9	154	79.4	78.1	63.9	34.3	68.3	80.6	53.3	
10	27	72.3	63.3	74.6	49.6	62.3	71.3	59.6	
11	17	78.4	71.3	86.0	56.0	69.7	79.3	64.1	
12	13	69.4	58.3	72.9	44.9	57.8	65.7	62.4	

TABLE 8. Energy consumption, average weekly temperatures, and average relative humidities for

BROODER HOUSE No. 21 — SERIES II

Weekly Average Temperatures, deg F

No. of week	Energy used per week kwh	Brooder House Max.	Brooder House Min.	Outside Air Max.	Outside Air Min.	Psychrometer at 8:00 a.m. Wet bulb	Psychrometer at 8:00 a.m. Dry bulb	Av. relative humidity, per cent	Av. brooder temp. deg
1	72	52.0	41.4	42.4	23.9	43.7	48.0	70.1	104.1
2	73	52.4	38.1	45.1	26.1	40.4	43.7	75.6	99.3
3	66	52.4	38.6	49.4	30.9	40.4	43.1	79.6	94.0
4	54	52.4	43.3	53.9	34.9	43.0	47.1	71.4	90.0
5	50	63.6	47.3	62.7	36.4	45.9	52.6	59.0	84.7
6	36	51.9	40.1	46.7	29.7	40.4	45.1	65.6	78.6
7	35	54.6	45.3	53.0	35.0	47.0	53.0	62.4	75.9
8	31	58.3	47.9	54.7	32.9	43.6	50.3	57.9	76.0
9	11	64.3	47.4	63.9	34.3	48.6	57.0	51.6	
10	10	73.1	63.1	74.6	49.6	59.7	67.4	63.4	
11	11	78.6	70.1	86.0	56.0	68.4	77.3	64.0	
12	10	71.5	59.7	72.9	44.9	57.4	65.4	61.4	

TABLE 9. Energy consumption, average weekly temperatures, and average relative humidities for

BROODER HOUSE No. 22 — SERIES II

Weekly Average Temperatures, deg F

No. of week	Energy used per week kwh	Brooder House Max.	Brooder House Min.	Outside Air Max.	Outside Air Min.	Psychrometer at 8:00 a.m. Wet bulb	Psychrometer at 8:00 a.m. Dry bulb	Av. relative humidity, per cent	Av. brooder temp. deg
1	80	51.0	41.5	42.4	23.9	41.0	45.9	63.2	104.1
2	73	50.9	40.1	45.1	26.1	40.6	43.7	77.1	99.4
3	70	49.9	39.4	49.4	30.9	40.6	43.9	76.6	94.1
4	55	49.7	43.6	53.9	34.9	42.0	46.4	70.3	89.1
5	41	60.4	48.3	62.7	36.4	46.4	52.7	61.4	85.1
6	33	48.4	41.1	46.7	29.7	40.3	44.3	69.9	75.1
7	37	50.9	46.0	53.0	35.0	46.4	51.7	67.1	79.1
8	29	56.0	48.4	54.7	32.9	45.6	52.1	60.1	75.0
9	12	56.9	49.1	63.9	34.3	49.4	57.0	57.7	
10	12	67.3	62.3	74.6	49.6	59.7	67.6	62.9	
11	12	75.6	73.6	86.0	56.0	68.7	77.6	63.4	
12	11	69.9	59.4	72.9	44.9	57.4	65.1	62.9	

TABLE 10. — Energy consumption, average mean temperature, and average relative humidity for all brooder houses

House	Series I—Nov. 27 to Feb. 20: Average mean temperature, deg F	Series I: Average relative humidity, per cent	Series I: Energy, kwh	Series II—Feb. 26 to May 20: Average mean temperature, deg F	Series II: Average relative humidity, per cent	Series II: Energy, kwh
19	69.4	39.5	2369	75.5	57.5	1849
20	44.0	75.0	377	75.2	52.5	2205
21	44.1	74.1	383	54.5	65.1	459
22	69.5	42.7	2502	53.3	66.1	465

houses were practically identical. Fig. 6 shows the temperatures obtained during Series I.

Discussion. As shown in Fig. 6 and Tables 2, 5, 6, and 7, the temperatures in the "hot" houses in both series were, almost without exception, kept well within the allowed ± 2.5 deg temperature variation from 75 deg F. Also, as shown in Fig. 6 and Tables 3, 4, 8, and 9, it was found possible to keep the temperatures in "cold" houses 20 and 21 from falling below 35 deg F. As pointed out previously, the desired constant mean temperature of 35 deg F could not be maintained because refrigerating equipment was not available to remove the animal heat developed by the chickens, the heat generated by the light bulbs, and the electric brooder. It is interesting to note that the brooder house temperatures for the cold houses fluctuated with the outside air temperature with approximately the same differential (Fig. 6) and the same lag in time.

Table 10 gives a summary of temperature, humidity, and energy for the two series of experiments during the twelve weeks of each brooding period. In the first series there was a wide difference in relative humidity between the "hot" and "cold" houses. In the second series this difference was greatly reduced. A most striking similarity in temperature, relative humidity, and energy consumption for cold houses 21 and 22 was found in the second series where differences of only 1.2 deg temperature, 1.0 per cent relative humidity and 6 kwh were obtained. The relative humidities, the average mean temperatures, and the energy consumptions obtained in cold houses 20 and 21 in the first series are also nearly alike. During the second series it was possible to maintain fairly uniform average mean temperatures in "hot" houses 19 and 20. The greater energy consumption for house 20 in this series may be due, in part, to a greater number of air changes, than in house 19. The actual amount of air handled by the exhaust fans was not determined definitely.

The prime function of these tests was not a determination of the relative merits of the insulating materials used, but the provision of definitely controlled temperatures and humidities for the experimental flocks, in studying the effects of air-conditioned environments for the growing chicks during their brooding period.

SUMMARY

1 Insulation plays an integral part in maintaining desired temperatures and humidities in poultry brooder houses.

2 It was impossible to hold the brooder houses at a temperature of 35 degrees F without refrigeration, even in winter brooding.

3 There was a wide difference in relative humidity between the "cold" and "hot" houses when moisture was not supplied in the latter in the first series.

4 The difference in relative humidities in the "cold" houses 19 and 20 without additional moisture was but one per cent. In the "hot" houses 21 and 22 with additional moisture in the second series, the difference was 5 per cent. This is probably due, in part, to the variation in the number of air changes in the respective houses.

(*Acknowledgments* The assistance of Albert Lutz, James B. Steere, and Roy Johnson in conducting these experiments is gratefully acknowledged.)

Lining Up an Irrigation Pump Pulley

OFTENTIMES a farmer in irrigating has difficulty in keeping the belt on the pulley wheels, because the motor and the pump get out of line. A farmer near Coloma, Michigan, anchors his pump by chain to a post so that it can be swung into line easily by a slight shifting of the intake pipe which lies in the stream or other source of supply, according to F. E. Staebner of the USDA Bureau of Agricultural Engineering.

Correction Notices

IN THE paper entitled "Farm Electric Milk Cooler with Pneumatic Agitation" published in AGRICULTURAL ENGINEERING for July 1936, on page 283, second paragraph, right hand column, this paragraph should be corrected to read as follows: "The cooling water never exceeds 34 degrees *after the first hour,* when six cans of 90-degree milk are placed to cool at one time, etc."

In AGRICULTURAL ENGINEERING for November, page 482, under the heading — What Agricultural Engineers are Doing — lines 16 and 17, under the report from the University of California, should read "This machine consists of 3 sets of rubber covered steel rolls" instead of "copper covered rolls."

Some Engineering Aspects of Terrace Outlets and Waterways

By C. L. Hamilton

RECENT development of erosion-control technique has developed new engineering problems and the need for a new application of some fundamental engineering principles, as well as new engineering materials and uses. The final outcome has been a tremendous expansion of the field for agricultural engineers in erosion-control work. This relatively new field involves problems dealing with the sciences of hydraulics, hydrology, construction, soils, and other subjects related to soil and water conservation. Lack of experience, knowledge, and basic information in this field has led to the use of some false or haphazard procedure in dealing with these new problems in many cases, and satisfactory solutions will be delayed until all factors involved are determined and their fundamental relationships established.

Well-protected natural waterways or pastures are preferred for terrace outlets wherever available and suitable, but these cannot always be found. Since artificial terrace outlets are necessary in many areas, the construction and control of erosion in terrace outlet channels is one of the most important of the new problems confronting the erosion engineer. This problem has naturally divided itself into two phases, outlets in which mechanical measures are used to control erosion, and outlets in which vegetative measures are used to control erosion.

Vast strides have been made in the last few years in determining proper procedure toward establishing outlet ditches with mechanical control measures. It has been fairly well demonstrated that masonry weir notch dams properly constructed and located with relatively flat grades between structures will give adequate outlet protection. Masonry weir notch spreaders properly constructed and located with overlapping vertical sections also seem to give adequate protection in certain soil types. Furthermore, it is generally conceded that mechanical protection will always be necessary in areas where large volumes of runoff are encountered or where drought and soil hazards make the establishment of adequate vegetation undependable.

The development of proper design and construction criteria for outlet ditches protected with vegetation has not kept pace with similar development in mechanically protected outlets. Today engineers can design, construct, and predict ultimate capacities and results for mechanically controlled outlets with a much higher degree of accuracy than for vegetated outlets. This condition is probably due to three reasons: (1) Sufficient basic information was not available to start with; (2) more variable factors are encountered; and (3) too often vegetative control has been considered a strictly agronomic problem, and consequently neglected by engineers.

The need for the development of cheaper and more practical measures of controlling erosion in outlet ditches demands that more attention and experimentation be directed to the determination of proper use and limitations of vegetative outlets. This is particularly true in regions where drainage areas are relatively small and rainfall is adequate to support vegetation.

This paper will, therefore, deal primarily with this latter problem since the time allotted to this subject makes it impossible to cover all phases of the terrace outlet problem. The problem will be discussed from a general and national standpoint. A brief review of methods of attack, present status, and further needed information will be included. It will not be possible to include all the construction details that have been used in various field areas.

Only a few years ago, very few, if any, engineers gave serious thought to possible use and application of sod as an engineering material in construction work. All the work and experimentation with this type of vegetation was generally considered as purely agronomic. As a matter of fact, vegetation in construction work was often considered a detriment by most engineers because of its tendency to obstruct flow in water channels and drainage ditches and the maintenance work required when used on other types of construction work. Wherever the establishment of some vegetation may have had beneficial effect on construction work, it was usually given secondary or minor consideration by the construction engineer, and quite often neglected altogether.

Recent development in the establishment of terrace outlets and waterways tends to indicate that sod and similar vegetative cover must be recognized as an engineering material, for the most satisfactory results. I believe that vegetation should be considered and treated in the same manner that engineers have treated such materials as earth, gravel, masonry, metal, timber, or rock, because it is simply another possible material for lining water channels. In all construction work, the engineer must first select the material that is most suitable for the particular job. Vegetation must be treated as one of the possible lining materials for terrace outlet channels and selected for use on all channels where it will provide the most economical and satisfactory results.

In designing ditches and in computing the discharge of water channels, both natural and artificial, the engineer must be familiar with the laws which govern the velocity of flowing water and he must understand the use and limitations of the empirical formulas which attempt to express these laws. When proper coefficients are applied, the use of well-established Chezy, Manning, and Kutter formulas enable the engineer to design and compute with reasonable accuracy, the probable velocity and discharge capacities of various types of earth ditches, as well as waterways lined with such materials as concrete, masonry, rock, cobblestone, metal, brick, lumber, etc. This has been made possible by extensive experimental work to determine proper roughness coefficients, and permissible channel velocities for each respective channel lining. Before erosion engineers can intelligently design waterways for this new channel lining material, determine its proper application and limitations in construction work, similar basic information is necessary.

Due to the unusual type of channels encountered in

Presented before the North Atlantic Section of the American Society of Agricultural Engineers at Skytop, Pa., October, 1936.

Author: Agricultural engineer, engineering section, Soil Conservation Service, U. S. Department of Agriculture.

vegetative terrace outlets and grassed waterways, broad shallow channels on comparatively steep slopes, there may be some question as to whether or not the relationships established by the common channel formulas will hold for these new channel conditions. In the main, these formulas were derived by extensive experimentation on channels of a different general type. To prove or disprove this point will require considerable time and investigation. Present conditions do not indicate that experimentation of this type will be undertaken. The general nature of all channel formulas, together with the fact that the Chezy formula, established in 1775 from fundamental hydraulic relationships, is the basis of all modern velocity formulas, tend to discourage the undertaking or need of such experimentation.

The flow of water in open channels has always presented a complicated problem in engineering work because of the variety of channel shapes, slopes, cross sectional areas, and linings, together with variations in degrees of roughness and safe channel velocities. Further complications often arise because of discrepancies and apparent inconsistencies in original experimental data.

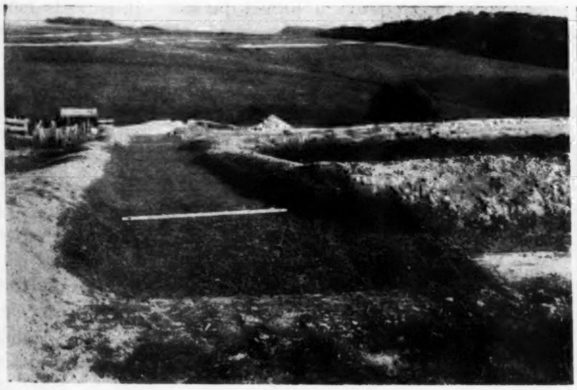
The determination of proper roughness coefficients and safe velocities for channels lined with vegetation becomes even more difficult when it is realized that each variety of grass as well as each soil type upon which it grows offers different degrees of resistance to channel scouring and flow. In other words, certain grass varieties and soil type combinations will likely withstand much higher channel velocities without damage than others. This degree of resistance to flow and scouring will not only vary with the kind of grass and soil combinations, but it will also vary considerably with the condition of the vegetation. Season of the year, drought periods, rainfall distribution, method of establishment, age, soil fertility, maintenance facilities, etc., will be some of the variables that affect the condition of the vegetation and must be taken into consideration in developing national or regional specifications.

It is evident, therefore, that even in spite of the simple appearance of this new type of channel, its analysis for design purposes presents a problem of greater magnitude than any other type of channel, and its ultimate solution will require extensive experimentation. For immediate purposes some experimentation will be necessary to determine proper roughness coefficients and maximum permissible channel velocities for main types of grasses that will be used for this purpose; then some factor of safety, its magnitude depending on location and degree to which the other variables are present, will have to be applied. For the present, field observations will undoubtedly have to play an important part in determining what effect each of the variables present should have in determining the proper factor of safety.

To date, a start has been made to determine proper roughness coefficients and safe channel velocities for design purposes and considerable experimentation has been done by the engineers on various Soil Conservation Service demonstration projects and ECW camps to determine the most practical methods of procedure to use in establishing the vegetation itself.

Prior to the transfer and establishment of the Soil Conservation Service in the U. S. Department of Agriculture, the Bureau of Agricultural Engineering recommended the value of $n = 0.04$ as the roughness coefficient for small grassed channels. This recommendation was made from the results of numerous studies which engineers from the Bureau had made on drainage, irrigation, and stream channels. This value has been accepted and used quite extensively in field design work for grassed channels and its general use will undoubtedly continue unless some future experimental work proves that it is not correct. The Bureau of Agricultural Engineering also made a preliminary recommendation of 5 fps (feet per second) as maximum average channel velocity and used these figures, together with certain flow-depth recommendations, as the basis for the preparation of a set of vegetative outlet ditch design curves which were used quite extensively by some of the early ECW camps on soil erosion work. The latter recommendations suggested flows of less than 6 in on grades greater than 9 per cent; less than 8 in on grades greater than 5 per cent; less than 1.0 ft on grades greater than 3 per cent; less than 1.5 ft on grades greater than 1.5 per cent; less than 2.0 ft on grades greater than 0.5 per cent.

Some preliminary recommendations were made by the Soil Conservation Service engineers toward establishing certain width-depth channel ratios, and a set of vegetative outlet ditch design curves based on these recommendations was prepared. It was recommended that channels designed for flood flows be proportioned so that b/D does not



(LEFT) VEGETABLE TERRACE OUTLET CONSTRUCTED IN WISCONSIN BY SOLID SODDING WITH BLUEGRASS. THE FINAL DROP AT THE LOWER END OF THE DITCH IS PROTECTED BY MASONRY STRUCTURES. THIS DITCH WAS CONSTRUCTED IN 1934, DESIGNED FOR MAXIMUM AVERAGE VELOCITIES OF 5 FPS AND HAS GIVEN SATISFACTORY RESULTS TO DATE. (RIGHT) TESTING A BERMUDA SOD-STRIPPED OUTLET DITCH ON A 5 PER CENT SLOPE NEAR SPARTANBURG, S. C. THE SOD STRIPS WERE 2 FT WIDE AND ON A 6-IN VERTICAL INTERVAL. AFTER 12 HR OF FLOW WITH VELOCITIES VARYING FROM 2 TO 8 FPS, THERE WAS CONSIDERABLE SCOURING AND PITTING BETWEEN STRIPS, BUT THE SOD STRIPS WERE NOT DAMAGED APPRECIABLY

exceed 10. While some general field observations were made by all engineers on the original Soil Conservation Service projects, the most intensive studies recorded to date were made on Project 2, Lindale, Texas, under the supervision of Howard Matson, and on Project 1 at Spartanburg, S. C., where a temporary hydraulic experimental laboratory was established under the supervision of J. T. McAlister. R. C. Johnson, University of South Carolina, directed the detailed work of the latter experiments.

Mr. Matson's studies, in Texas, on numerous channels sodded with Bermuda grass, and designed for a maximum average velocity of 5 fps, indicated a decided silting tendency, even when closely grazed. As a result of these studies and other field observations, Mr. Matson recommends maximum design velocities of 8 fps, except on the flatter grades where this may result in channels of excessive depth. In the latter case velocities as near the maximum as possible and a minimum of 5 fps were suggested. A minimum channel width or section that would just permit field mowing and a maximum channel width of about 20 ft also seemed to be most desirable. The regional engineering handbook from this region now contains the following statement:

"So far as is known by observation and experience to date, the volume of runoff water which may be safely carried in a sodded channel is limited by the maximum velocity of 8 fps and bed width of 20 ft. By the use of 4:1 side slopes the volume of water carried may be increased without increasing the velocity or bottom width of channel. Another possibility in the case of large drainage areas is the use of parallel adjacent sodded channels, each being individually designed. Excess dirt from such channels may be placed in the ridge separating them, but the slopes should be such that the ridge may be mowed."

A few of the experiments conducted at the outdoor hydraulic laboratory on Project 1, Spartanburg, South Carolina, were devoted to the determination of maximum permissible velocities of Bermuda grass sodded waterways. One experiment, on a solid sodded channel with 22.5 per cent slope, showed that for 30 min flow with maximum velocities of 12 fps and average maximum velocity of 6.8 fps, no damage was done to the sod. This channel carried 3.6 sec-ft. It was felt that failure of this particular flume after 30 min of operation was due to a portion of the sod being on a large rock.

Another test on the same channel showed that the sod began to fail in spots after 25 min of operation with maximum velocities of 14 fps and average maximum velocity of 9.7 fps. In the latter case the sections that failed were six days old and the channel carried 6.5 sec-ft. A value of Kutter's *n* was, incidentally, found to be about 0.032 in these experiments where the channel was fairly uniform, the grass short, and there were no weeds.

Another test involving a 12 hr flow, with maximum velocities varying from 2 to 8 fps on a channel stripped with sod strips, indicated minor damage to the channel. As a result of these preliminary tests and field observations, Prof. Johnson made the following recommendations:

1 For design purposes the maximum calculated velocity for solid sodded flumes should be limited to 10 fps, based on a 10-yr runoff.

2 Kutter's *n* should be assumed to be 0.04 for field conditions.

3 For design purposes the maximum calculated velocity for sod strips in channels should be limited to 8 fps, based on 10-yr runoff

4 In general, sod strip treatment should be avoided for slopes greater than 5 per cent, due to the unavoidable scouring between strips, even on low flows.

It was felt that the period of time covered in the above tests would equal the duration of intense flows from ordinary rains, but it must also be realized that the vegetation used in these tests was not exposed to the soil or drought hazards that would be experienced under actual field conditions. Some further field exploratory studies made by engineers in the Spartanburg area indicated several fundamental considerations in the establishment of satisfactory sod waterways:

1 Solid sodding gave a much lower percentage of failures than strip sodding.

2 Failures were much lower in channels where the vegetation benefited by one growing season before being exposed to runoff from intense rains.

3 The predominant cause for a large number of failures was poor foundation material for the sod. Results showed that placing sod over gravel, rock, shale, tree roots, subsoil, particularly *"C"*, material, etc., prevented the sod from securing necessary bond to resist surface flows.

4 The wider the strips and the smaller the vertical interval between them the less the chance of failure, but the cost of constructing initial ditch is increased. Poor foundation soil should have wider strips than good soil and the use of spreaders to supplement strips seemed helpful, provided they were placed flush with bottom of the channel.

Field observations in the north central states, where bluegrass is the predominant native vegetation, indicate that as yet there seems to be no reason to deviate from the original vegetated channel design assumptions recommended by the Bureau of Agricultural Engineering, except as to the use of spreaders. As a matter of fact, maximum design velocities of 5 fps seem to be amply high where bluegrass sod is used. Well-established bluegrass sod will likely withstand just as high velocities as Bermuda grass sod, but a larger factor of safety will probably be found necessary for the bluegrass area because of the greater influence of vegetative hazards. Bluegrass is more difficult to establish and requires a longer period. It spreads more slowly and is more easily destroyed. Drought periods are more often encountered, seasonal rainfall is less and more unevenly distributed.

In the north central states, the most successful artificially vegetative outlet ditches were secured by solid sodding on good foundation soil. These channels were designed with flat bottoms according to above recommendations, sod firmly placed on good foundation soil, and the bottom of outlet ditches placed slightly below terrace channel elevation at outlet end. The drop between terrace channel and outlet ditch was sloped and sodded to prevent overfall from starting up terrace channel. The majority of attempts to establish vegetative outlet ditches by strip sodding, either with or without spreaders and by seeding, have been failures except, probably, where all the runoff could be diverted from the outlet channel during the establishment period. Where diversion of runoff is not practical, it seems as though the establishment of vegetative waterways by strip sodding and seeding will never be very dependable in this area. Any obstruction, such as strips or spreaders, across

the bottom of the channel seems to cause sufficient turbulence to effect harmful pocketing both above and below the obstruction even though they are set flush with the bottom of the water channel. This condition has not been experienced to the same degree in the Bermuda grass areas, probably because of different soil characteristics. A large portion of the attempts to establish vegetative waterways from seed without runoff diversion has resulted in the loosened seedbed and seed being washed from the channel before it could become established. While temporary water diversion is practical in some cases, it usually introduces additional problems and increases the cost of establishing vegetative waterways. The use of temporary structures in terrace outlet channels seem to be of little, if any, value and their use has been discontinued in practically all areas.

In the northeastern states very little, if any, information is available as to the proper procedure to follow in designing and establishing vegetative terrace outlet channels, because it has been impossible to make even preliminary field observations of results secured. Prior to the establishment of the Soil Conservation Service activities, no terracing was done in this area, and it is only recently that the first few demonstrational terracing jobs have been completed. This information, however, will be necessary and must be developed for this area because field and cropping conditions indicate that considerable terracing will be necessary in certain areas of the northeastern states.

The establishment of vegetative waterways before the construction of terraces has been advocated in several areas as a possible solution. This procedure may solve the problem to a certain extent, but it will also introduce some new factors that will tend to offset any advantages in many areas. The proper vegetation may take several years to become adequately established, and, in the meantime, the delayed terrace construction will result in large quantities of soil loss through sheet erosion. Complete terrace layouts are apt to be planned less efficiently, and the total construction costs will likely be increased due to the two different periods at which the work is done.

The use of wide, grassed waterways in place of a formed outlet ditch has been advocated and has some possible advantages after it is established. Less experimentation has been done with this type of artificial outlet, however, and less information is available to determine its limitations or the most practical procedure to follow in its establishment.

It is evident, therefore, that engineers still have an important problem to solve before vegetative outlets can be used most efficiently and effectively. It is not my intention to make this problem appear more difficult than it really is. The main purpose of this paper is to show the need for engineers directing more attention to the problem and to give a brief review of its present status in some sections of this country. Even the preliminary recommendations now available are open to question because it has been impossible to give proper consideration to all field variables. Inadequate experimentation has been done to date to fully determine the necessary basic design assumptions and what factor of safety must be applied in the various regions. Besides establishing this design criteria, further developments are necessary to determine the most efficient and effective procedure to use in establishing necessary vegetation under the various field conditions.

Certain assistance can, undoubtedly, be secured from agronomists on this problem, but it is my belief that the information which is most urgently needed is that dealing with the engineering phase — proper design, construction procedure, and limitations. Some maintenance work will always have to be depended upon, but until the above factors are fully determined, vegetative water channels will always be handled in a more or less haphazard manner.

What Agricultural Engineers Are Doing

Contributions Invited

All public-service agencies (federal and state), dealing with agricultural engineering research and extension, are invited to contribute information on new developments in the field for publication under the above heading. It is desired that this feature shall give, from month to month, a concise yet complete picture of what agricultural engineers in the various public institutions are doing to advance this branch of applied science.—EDITOR.

Reported from the Agricultural Engineering Department, South Dakota State College

THREE experimental projects or phases of projects under way here might interest the manufacturing industry:

"Corn Harvesting Machinery", Project No. 2 in agricultural engineering, has been in progress for several years. A husker-elevator machine has been built for the purpose of husking snapped corn as it is elevated into the crib at the farmstead. The machine is portable and compact, and can be used with any farm elevator. It does a cleaner job of husking than the field machine and has a capacity at present of 150 bushels per hour. The corn husks are salvaged for feed and for other purposes, and the shelled corn that is lost at the rolls on the picker-husker is saved. The load of the heavy husking rolls is taken off the field machine and the speed of harvesting is increased. The machine is a community unit, and designed to operate in conjunction with field snappers.

"The Two-Row Cultivator Converted Into a Rigid Weed-Control Machine," was a phase of work under agricultural engineering project No. 5. The possibility of using the row cultivator for a weed control machine on small, weed-infested areas, in addition to its regular work, was considered and tried out.

A two-row, shovel-equipped cultivator was used for his work. The gangs were made rigid by bolting two pieces of angle iron crosswise of the four gangs, and additional shovels were mounted between the gangs. Some of the shanks were removed, and those remaining were equally spaced and various types of shovels were tried out on field bindweed and quackgrass. The shovels were finally spaced 8 to 8.5 in apart. A tractor hitch was devised so that the machine could be pulled with a tractor. The result is an efficient weed control machine 7.5 ft wide, equipped with 11 shovels.

On small weed-infested areas this weed-control machine makes a good substitute for special weed machinery.

"Transparent Covering for Pise' or Rammed Earth Walls," is a phase of work under project No. 4. A study of transparent paints and protective coverings is being made with the hope of finding a satisfactory transparent protection for earth walls. In dwelling house construction it is especially desirable to preserve the identity of the earth wall. Suggestions from paint manufacturers or others that may help in this problem will be gratefully received.

Another new phase of study in rammed earth is a cooperative project with the poultry husbandry department on chick brooder house construction. A stationary five-pen brooder house with 14-in rammed earth walls has been built to match a frame brooder house of the same dimensions. Identical hot water heating plants have been designed and will be installed. Comparative temperature and fuel tests will then be made on these houses.

NEWS

Blasingame Represents ASAE in Diesel Celebration

R. U. BLASINGAME helped celebrate the 40th anniversary of the introduction of diesel power into the United States as representative of the ASAE on the Diesel Committee of the Exposition of Power and Mechanical Engineering which opened in New York City November 30. He had to leave the ASAE winter meeting in Chicago December 1 to be at the Exposition on "Diesel Day," December 2.

A feature of "Diesel Day," arranged by the committee was a luncheon at the Waldorf Astoria attended by a distinguished group of leaders in business, industry, and engineering, at which the memory of Dr. Rudolf Diesel, inventor of the diesel operating principle, was honored. This is the first time general public attention has been called to the progress and importance of the diesel industry.

The committee of eighteen prominent men which sponsored the program includes, in addition to Mr. Blasingame, chairman Gordon Rentschler, president of the National City Bank of New York; Charles F. Kettering, vice-president of General Motors Corporation; Col. Robert H. Morse, president of Fairbanks-Morse and Co.; B. C. Heacock, president of Caterpillar Tractor Co.; David S. Sarnoff, president of Radio Corporation of America; Capt. Edward V. Rickenbacker, vice-president of Eastern Air Lines; Walter C. Teagle, president of Standard Oil Company of New Jersey; B. F. Fairless, president, Carnegie Illinois Steel Corporation; Frank A. Vanderlip, Sr.; Arthur Brisbane, and others.

Washington News Letter

from AMERICAN ENGINEERING COUNCIL

ELECTION results recording President Roosevelt's remarkable victory do not solve major national problems. On the contrary, it may be safely said, without partisanship, that the unusual success at the polls tremendously increases the administration's responsibilities. Among the less fortunate results are demands already expressed for the continuation and expansion of several "emergency activities". Sponsors argue that election returns constitute an endorsement of such activities. Consequently, they are seeking new orders to go ahead regardless of improving conditions. Other problems of even greater importance are: an unbalanced budget; real need for federal government reorganization; more definite policies regarding public works expenditures, sympathetic but courageous decisions as to methods of continuing relief activities; evolution of procedures for the better conservation of national resources; sane legislation affecting minimum hours and wages; determination of the federal government's proper relation to integration and control of private and public power supply and distribution; consideration of troublesome details involved in making social security effective—all of these and many others await solution.

It is too early to know the direction in which the new administration will move. Maybe toward "the left" in the direction of further socialization of natural resources and more centralization under federal auspices; or toward "the right" with more reliance upon initiative, enterprise and leadership of industry and trade. In any event, engineers share with other leaders in the professions, industries and trades the responsibility of making their opinion known to the administration. Engineers have a responsibility in the determination of the public policies—not only with professional contributions on technical problems involved in these questions, but in finding means to express opinions collectively in the public interest with reference to sound procedures. Their counsel and judgment on problems facing the nation were never needed more than today. Engineers are challenged to encourage engineering societies to take a more active part in public affairs by the practical observation that as engineers get into the civic affairs of communities, greater recognition is accorded the profession, resulting in correspondingly greater influence and increasing opportunities to help improve government practices.

Some forty-five national, state and local engineering societies are now represented in Washington, through the staff and committees of American Engineering Council which is a nontechnical organization maintained by the engineering profession to further public welfare wherever technical and engineering knowledge and experience are involved and to act upon matters of common interest to the engineering profession. American Engineering Council is known to government agencies and members of Congress for expressions of united engineering opinion on most of the questions suggested above. As the glamour wears off of emotional arguments and the administration and the new Congress become receptive to realistic thinking, orderly analysis and fact finding, Council is concentrating on the presentation of mature engineering experience and judgment in a nonpartisan spirit with the public good as the major objective. Consideration of both what to do and how to proceed will occupy the attention of representatives of member organizations to the annual meeting of American Engineering Council, January 14-16, 1937, and it is anticipated that, as in the past, the delegates will recognize the vast possibilities in unity of purpose, and creditably represent the engineering profession in making valuable public contributions toward the solution of those national problems with which engineers are associated professionally, and as leaders of thought and opinion.

* * * *

Rural Electrification's current release shows a material acceleration in loans to both the publicly owned light and power cooperatives and privately owned light and power utilities engaged in rural electrification. On October 30, 1936, it had lent or definitely earmarked a total of $35,728,178 to build about 32,000 miles of rural electric lines to serve over 120,000 customers with either privately or publicly owned central station electricity. Celebrating the anniversary of the first loan contract on November 4, 1936, REA announced that nearly 1500 miles of rural electric lines have been energized and that 4200 farm families are already using electricity for the first time.

* * * *

Bureau of Public Roads' summary for the year ending June 30, 1936, shows contracts awarded for 22,300 miles, at a cost of $489,000,000, of which $393,000,000, was to be supplied by Federal Government agencies. Work actually under construction totalled 21,800 miles, at a total cost of $454,000,000, of which the cost to the Federal Government is to be $369,000,000. The 17,300 miles of road completed were built at a total cost of $380,000,000, including $241,000,000 in federal funds. During the fiscal year, 300 railroad grade crossings were eliminated, 18 temporary elimination structures were reconstructed and protective devices were installed at 185 crossings. At the end of the year, 1240 eliminations were under contract for construction, 168 elimination structures were under contract for reconstruction. Highway work administered by the Bureau is said to be supporting more than one million people.

An interesting recent report by the Bureau states that highways are now being designed for the safe accommodation of vehicles moving at rates of speed up to 60 miles. This applies to new highways as well as a large mileage of the older highways being undertaken by successive stages. In most cases, the adaptation of existing highways is done by relocation, corrections of alignment, and, in rare instances, by the selection of entirely new locations for trunk lines. Other improvements adding to safety at the higher speeds include a general widening of road surface, the complete separation of lanes for opposing traffic where a density of traffic requires more than two lanes; the elimination of the more dangerous railroad crossings, the provision of by-pass routes around towns and cities, and the improvement of routes of direct access to the centers of cities.

Improvement of roadsides by landscaping, grading, seeding, sodding and planting is becoming increasingly popular and the Bureau of Public Roads reports 1,391 sections of roads improved according to plans by landscaping specialists. This work already involves over 5,000 miles of highway at a total cost of more than $7,000,000, of which the Federal Government is reported to have contributed more than $6,000,000. State Highway Department organizations are providing for an improved technical approach to the various roadside problems, and they are developing more effective methods of handling the work. The earlier over-emphasis on fancy planting and landscaping is being balanced with the use of native trees and other forms of natural beauty and with the elimination of "borrow" pits, and better "clean-up" after construction.

* * * *

Director Robert Fechner is urging the President to make the Civilian Conservation Corps a permanent organization, with a corps of some 350,000. He expresses the belief that such an organization is essential to public welfare, and cites the tremendous need for reforestation, erosion control, conservation and rehabilitation, having as their objectives the further preservation of our natural resources. In support of the recommendations, Director Fechner placed the record of the CCC, which we have referred to in other issues, before the President and stressed the fact that CCC contributions are not competitive with private industry.

Works Progress Administration has allotted $5,500,000 to the Engineers Corps of the Army for flood control studies, authorized by the last Congress. The appropriation which Congress intended to make for that purpose died in the hectic hours of the last session. Being work relief funds, the WPA allotment carries relief restrictions to employment and compensation, which lead to difficulties in the mobilization of engineering forces. The only exemption obtained to date permits the employment of engineers on flood control studies for 130 hours per month at prevailing wages. Prevailing wages in this instance is interpreted as being the same as those paid under civil service for comparable performance.

The Army's flood study program is creating many opportunities for engineers, but unfortunately the relief restrictions keep most of them in the subprofessional classification. As a result of the confusion, competition is developing among emergency agencies using relief funds, and state administrators of the Works Progress Administration are being urged to abandon the less essential projects and allow the transfer of technically trained employees to the flood surveys.

* * * *

The President's committee on government reorganization seems to be concentrating its efforts on a confidential study of government management and personnel problems, leading to a complete reorganization of the system in which government servants are recruited, promoted, demoted, pensioned, or eliminated from the service. Confidential personal reports to the President are said to carry recommendations for the establishment of a "career service" to take the place of the present mixture of civil service and emergency and unclassified employees depending upon patronage. It is rumored that the career service would be patterned after the "British Career Service." Such a system would include administrative, professional, clerical, skilled, semi-skilled and unskilled employees, and would determine the proper classification in individual cases by examinations for each category. The plan provides that new employees undergo a period of probation, after which they become members of the career service, removable only for cause. Vacancies in the better jobs would be filled by promotions from the lower classification on the basis of capabilities.

Council's staff is checking the reported recommendations of the President's committee with reference to both content and seriousness. As soon as the real intent of the report can be determined, our organization will exert its full influence for a merit system free from social and political control and bias.

* * * *

AEC ANNUAL MEETING AND SECRETARIES CONFERENCE

A special committee of secretaries is arranging an unusually interesting schedule of sessions for the Secretaries' Conference on January 14, and the meetings of Council's Assembly on January 15 and 16 are being arranged to bring the opinions of committees and representatives of member organizations to bear upon problems of most concern to the engineering profession and the public welfare. All Engineers' Dinner on the evening of January 15 is commanding much more than usual interest and nationally known speakers from public and private life will discuss subjects close to the heart of the engineering profession.

President A. A. Potter addressed some 200 members of the Cleveland Engineering Society on October 13 at Guild Hall in Cleveland, on "Opportunities for Engineers to Aid in Solving National Problems". Refuting the charge that technical progress is responsible for unemployment, Dean Potter showed that "Engineers are Creators of Employment" and pointed out that the continued development of new industries is essential to prosperity. In conclusion, Dean Potter stressed the point that it is a definite responsibility of the engineering profession to take an interest in the social welfare, the economic change, and the political standards of our nation.

"Unity of Action by Engineers, a Professional Necessity", was the subject of President Potter's speech to a meeting in St. Louis on October 15, sponsored by the Joint Council of Associated Engineering Societies of St. Louis. Engineers in St. Louis reported it as an inspiring address before a large and appreciative audience, and the Press carried the following stimulating extracts: "Our profession will insure more general well being in the future if we as a group assume wider responsibility for public questions of national scope and work for a well balanced social structure. The American Engineering Council appreciates the strength potential in cooperation among engineers. Accordingly, it is working for the unification of the engineering profession in viewpoint, thought and action, but does not interfere with the specialized fields or with the autonomy of its member engineering societies. It is concerned with the economic status of the engineer, the enhancement of his prestige, the extension of the merit system in public employment, and other matters intended for the advancement of engineering profession, and a better appreciation of the importance and value of engineering service. It is endeavoring to bring about concerted action on the part of the engineers in public questions and matters of vital importance to the general public welfare."

Pacific Coast Section Plans Land Utilization Program

A SYMPOSIUM on "Land Utilization" is being planned for the fifteenth yearly meeting of the Pacific Coast Section of the ASAE, to be held at Berkeley, California February 5 and 6, 1937, according to Walter W. Weir, secretary of the Section. The detailed program is to be announced later.

Distribution of Unpublished Papers and Reports

SPACE limitations have prevented the timely publication of many papers and committee reports presented at the annual meeting of the ASAE at Estes Park, Colorado, last June. Timely publication of winter meeting papers, and of a few section meeting papers of wide interest, will preclude publication of many earlier meeting papers in the near future.

Under these circumstances the ASAE will furnish on request mimeograph copies of any such papers and reports, not yet published or scheduled for early publication. The program of the annual meeting at Estes Park, as published in AGRICULTURAL ENGINEERING for May, 1936, and also separately, is suggested as an approximate guide to papers and reports available.

STUDENT BRANCH NEWS

Georgia Student Branch

GEORGIA'S Student Branch of the American Society of Agricultural Engineers reports the largest membership since its organization. We have 112 students enrolled in the agricultural engineering department, 85 of whom are local Branch members.

We have had three meetings this year, the first being on October 12, at which time each officer and faculty member gave a short talk. The chief purpose of this meeting was to get acquainted with all of the new students and faculty members. Enjoyable refreshments were served.

We were favored with an address from Paul W. Chapman, dean of the College of Agriculture, on "Opportunities for the Young Agricultural Engineer" at our second meeting on October 26. Mr. J. L. Shepherd, a graduate in mechanical engineering from North Carolina State College, who is completing the degree requirements here in agricultural engineering, also gave a short talk on "Student Life." Prof. R. H. Driftmier, on behalf of the agricultural engineering faculty, presented the Branch with a large silver plaque on which is to be engraved the name of the outstanding senior at the end of each year. The faculty is also going to present this senior with his first year's membership in the ASAE.

On November 9 the Branch initiated 38 members, and announced that a dance would be given on November 21, for all students in the College of Agriculture and School of Forestry.

The Georgia "AG ENGINEER," our annual publication, is getting off to a good start, and we hope to produce an even better one than last year.

Prof. F. W. Peikert, assisted by four students of the department, conducted the annual farm shop contest for high school students in vocational education at the Macon Fair, October 22 to 24. This contest covered four phases, namely, machinery, concrete, identification of builders' hardware, and rafter cutting. There were 22 teams entered in the contest, representing all parts of the state, and a great deal of enthusiasm and interest was manifested. First, second, and third prizes were awarded in each phase, and three grand prizes presented.

On November 5 and 6, twenty-three seniors and juniors, accompanied by Prof. Peikert, went on a two-day inspection trip to Atlanta and visited the machinery companies, railroad shops, steel works, foundry and packing companies. We had an oppor-

tunity to see in practice a great many things that we had studied in the class room, but had not had the opportunity to do in the laboratory. Prof. Driftmier also took the seniors and juniors on an inspection trip to three of the buildings being constructed on the University campus. Two of these buildings are of reinforced concrete construction and the other is steel frame construction.

On November 23, the Firestone Tire & Rubber Company presented a program on the "Use of Rubber Tires in the Agricultural Industry." This program included a sound movie and several short talks.

We will have one meeting in December, at which time the Bethlehem Steel Company are showing a new sound film describing and illustrating the manufacture of steel from the blast furnace on through to the finished material, emphasizing the manufacture of wire products. Officers for next quarter will be elected at this meeting.—*L. L. Reaves, Scribe*

Virginia Student Branch

OUR Student Branch at the Virginia Polytechnic Institute, began the school year with a membership of 43 as compared with 38 members last year. The entire curriculum enrollment is 78 as compared with 42 last year.

As has been the custom in the past, meetings are to be held each Thursday, at which talks are given by students, faculty members, and visiting speakers. We plan for one moving picture by some farm equipment company, and one smoker each quarter.

One of the four units of our proposed $150,000 building has been completed and is being equipped while the second unit is in the process of construction.

At our first meeting this year it was decided to buy and use letterheads for all official Branch correspondence.

At the second meeting student talks were given on the subjects "Canning Tomatoes," and "The Future of Agricultural Engineering."

Our quarterly smoker which served as a reception for the freshmen took the place of our third meeting, at which time faculty members made short talks and it was explained that freshmen were to get college credit for attendance at weekly meetings.

Talks on "Precooling Fresh Fruits and Vegetables", and "Small Combine Performance", were the subjects of the student talks at the fourth meeting. A talk on soil conservation was the most important feature of the fifth meeting. In our sixth meeting the topics "The Interchangeability of Lugs on Farm Equipment Wheels," and "Farm Water Supply for Fire Prevention," were given by student members. A ruling was made penalizing students failing to make talks on dates assigned, exceptions therefrom to be approved by the faculty advisor.—*S. P. Marshall, Jr., Scribe*

Wisconsin Student Branch

WISCONSIN'S Student Branch has published a 12-page pamphlet, "The Wisconsin Agricultural Engineer," giving information on the agricultural engineering curriculum and facilities of the University of Wisconsin, and a directory of graduates of the course during the past 15 years, as well as a list of undergraduates.

The publication was financed by prize money won by the Branch in the 1936 Engineers' St. Patrick's Day Parade.

A tribute to agricultural engineering students of the University of Wisconsin is paid by Dean F. E. Turneaure of the University's College of Mechanics and Engineering, in a letter to E. R. Jones, head of the agricultural engineering department, published in the pamphlet as follows:

"In recent years I have watched with interest the increasing numbers of agricultural engineering students who take the required work in mathematics and theoretical mechanics to qualify themselves for electing the courses in applied mechanics in the College of Engineering.

"I have observed too that the quality of the agricultural engineering graduates who come to the Engineering College to supplement their agricultural degrees with an engineering degree is high. We welcome such students to our Engineering College. I admire the spirit of a man who is willing to devote five years of undergraduate work to fundamental training in his chosen profession, and it seems to me the five-year combination course is a very excellent program for students who wish to enter the more technical fields of agricultural engineering.

"We are very glad to have your students join with those in the College of Engineering in their outside activities. Time was when our students in the College of Engineering were satisfied merely to borrow a tractor or two fram the agricultural engineering department to pull a float in the annual St. Patrick's Day parade, but for the last two years we have enjoyed the participation of the agricultural engineers as a group in this traditional parade, and we congratulate your group on the winning of first prizes each year. You should be proud of your boys, and we are gratified with the cordial cooperation among the students and between your department and the College of Engineering."

Missouri Student Branch

IN OUR Branch we have twenty active undergraduate members and several graduate students who attend meetings.

Our Branch met November 10, 1936. There was a discussion during the first part of the meeting. It was decided that the Branch continue having a hot-dog stand each year during Farmers' Week. There was also a vote passed that each member pay one-half of his part on our Branch Savitar picture, the remainder being taken from the club fund.

After the business of the meeting two films were shown, one of them was regarding western life and the other illustrating the development of transportation.

During the Farmers' Week, October 27 to 29, the Branch ran a hot-dog stand which made a total profit of $13.43.

The agricultural engineering department has started holding a seminar meeting on each Tuesday night that the Branch does not meet.—*Joe Park, Secretary*

ASAE Meetings Calendar

February 3 to 5, 1937—Southern Section (in conjunction with annual convention of the Association of Southern Agricultural Workers)—Nashville, Tenn.

February 5 and 6, 1937—Pacific Coast Section—Berkeley, Calif.

June 21 to 24, 1937—Annual meeting of the Society—University of Illinois, Urbana-Champaign.

Louisiana Student Branch

THE outlook for this year seems very bright for the success of our Branch. Early this month we hope to have our chapter rooms all furnished and arranged. Last year we were given enough lumber and space in the agricultural engineering laboratory to build this room, which we completed before the school year closed. We feel that it was a big step in getting this Branch started. It is our aim to make it one of the best in the whole organization.

Our object this year is to get our room completely fixed up and to win in the agricultural fair that the agricultural school here at Louisiana State University puts on every year. We are trying our best to show these folks around here what agricultural engineering is and what it stands for.

Members for this year are: S. McDonald Fullilove, president; F. A. Hodge, vice-president; W. A. LeBlanc, secretary; Eugene H. Graugnard, treasurer; A. P. Breaux, Allen H. Carlisle, and Robert F. Doles.

We send best wishes for a very successful year to all other branches.—*S. McDonald Fullilove, President*

Personals of ASAE Members

C. N. Hinkle, formerly instructor in agricultural engineering at Purdue University, has recently become associated with the Standard Oil Company of Indiana, as tractor representative in the technical department.

E. G. McKibben, associate professor of agricultural engineering, Iowa State College, is on leave of absence until June 15, 1937, serving as agricultural engineer for the national research project of the Works Progress Administration. His work is in connection with the section of the project which is studying the effect of changing agricultural technique on employment in agriculture.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the November issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Otto Burgdorf, sugar beet grower, Meridian, Calif.

M. D. Gjerde, technical department, Standard Oil Company, 910 S. Michigan Ave., Chicago, Ill.

Roger M. Kyes, second vice-president and general sales manager, Empire Plow Co. (Mail) 3673 Traver Road, Shaker Heights, Cleveland, Ohio.

L. B. Morehead, associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 500 E. High St., Mt. Vernon, Ohio.

E. W. Schroeder, agricultural engineering department, Pennsylvania State College, State College, Pa. (Mail) Woodsdale, R. D.

TRANSFER OF GRADE

Earl D. Anderson, agricultural engineer, Republic Steel Corporation, 7850 S. Chicago Ave., Chicago, Ill. (From Junior Member)

C. L. Hamilton, agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 1371 Somerset Place, N. W., Washington, D. C. (From Junior Member)

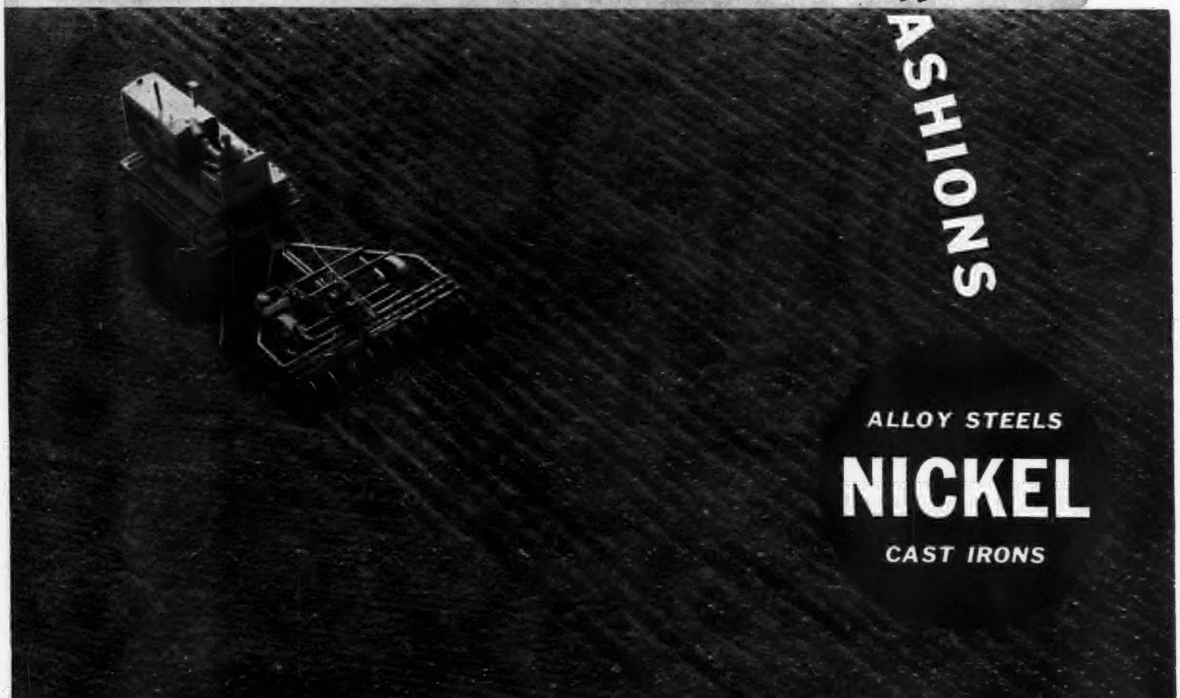
LOOKING DOWN ON THE NEW FARM FASHIONS

. . . WE SEE one of the new diesel tractors disc-harrowing an interesting pattern for a planting of beans. From this angle the going looks smooth. But down where the furrows lie there's plenty of wear and tear with frequent high stresses caused by speedy operation.

But there are new fashions in metals, too, to combat these destructive forces. For example, the Nickel Alloy Steels and Nickel Cast Irons. Rapidly they are supplanting the ordinary steels and irons of yesterday because they offer improved resistance to stress, shock, abrasion and wear.

Equipment engineers are turning to these alloys more and more because of their superior hardness, toughness and strength which lower the cost of upkeep by slowing up depreciation.

Our engineers will be glad to consult with you and to recommend suitable applications and compositions.



THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

SOIL CRUSTS. *A. Carnes.* Assoc. South. Agr. Workers Proc., 35 (1935), pp. 214, 215. In a contribution from the Alabama Experiment Station methods are described which were used in studying the mechanical properties of soil crusts in connection with efforts to overcome their injury to cotton stand.

It was found possible to reproduce crusts very similar to those found in field soils by sprinkling soil in the laboratory with large drops of water. The crusts appeared to be produced by the infiltration of colloids and later cementation of soil particles. The modulus of rupture was used as a measure of crust formation.

The amount of crust formed on a given soil varies with the amount of rain. It appears for the soils with the least hydrated colloids, such as Cecil, Sumpter, and Houston, that the relationship between rainfall and the force of breaking for each soil follows a general law whose form is $R = ae^{bx}$ when R is the modulus of rupture, a the intercept constant, b the slope constant, and x the amount of rain in inches. R is proportional to the surface in contact which is a function of pore space. The formula states that the rate at which the pore space fills up, under the action of water, is proportional to the pore spaces.

The rate of drying affects the breaking strength of crust. A slow rate of drying produces a crust slightly harder to break. The breaking strength of crust, formed under a given condition, was found to bear an inverse relationship, within the range studied, to the amount of moisture in the crust at the time of breaking. The chemical nature of the soil affects the breaking strength of crust. The modulus of rupture of the crust of soils studied is greater in cotton middles than on ridges.

Preliminary tests indicate that the injury to cotton stands, caused by crust formation, can be solved by the proper preparation of the seedbed before and at the time of planting. Planting cotton on a compacted seedbed affords a firm footing for the young plant in breaking through the crust and results in a more efficient use of moisture present in the soil.

POWER REQUIREMENTS IN COTTON GINNING PLANTS. *V. L. Stedronsky.* Assoc. South. Agr. Workers Proc., 35 (1934), pp. 215-217. In a contribution from the USDA Bureau of Agricultural Engineering the power requirements for cotton ginning are summarized.

ELECTRICITY SERVES THE FARM HOUSEHOLD. *G. M. Redfield* and *T. E. Hienton.* Indiana Sta. Circ. 214 (1936), pp. 12, figs. 10. This is a popular circular.

SOIL CONSERVATION IN AN IMPROVED AGRICULTURE. *M. F. Miller.* Missouri Sta. Bul. 362 (1936), pp. 15, figs. 7. This is a brief popular treatise on the subject.

THE RELATION OF SOIL EROSION TO CERTAIN INHERENT SOIL PROPERTIES, *J. F. Lutz.* Soil Sci., 40 (1935), No. 6, pp. 439-457, figs. 8. This paper reports upon an investigation leading to the conclusions (1) that the erosiveness of the Iredell is due to its ease of dispersion and to the dense, impervious nature of the B horizon, and that hydration is an important factor in its dispersion; and (2) that the nonerosive nature of the Davidson clay is due to the nonhydrated condition and the high degree of flocculation of the colloidal fraction into large, porous and stable aggregates.

It was found that the Davidson colloids flocculated irrespective of the kind of exchangeable cations on the complex, whereas only the H-, Ca-, and Ba- Iredel systems flocculated. Electrokinetic potentials of the Iredel, Davidson, and Putnam soils were practically the same, indicating that hydration, rather than charge, was the main contributing factor to stability of the suspensions. Swelling was in the order Bentonite>Putnam>Iredell>Davidson. This is the reverse of the SiO_2–R_2O_3 ratios. The K, Na, and Li cations showed no definite order of effect on the swelling of the colloids. The Ca, Ba, and H decreased swelling in the order named. Permeability of the different clay membranes was in the order H>Ba>Ca>K>Na>Li.

"These physicochemical properties of the colloids are paramount factors influencing the erosiveness of soils."

NOMOGRAM FOR CENTRIFUGAL FORCE, *H. Shapiro.* Indus. and Engin. Chem., Analyt. Ed., 7 (1935), No. 1, p. 25. This note presents a set of scales based upon the relation $C = 4\pi^2 n^2 r$ ($= 39.478 n^2 r$), in which C is the centrifugal force in dynes, n and r being the number of revolutions per second and the radius in centimeters, respectively. In the scale shown, C has been divided by 980, giving the RCF (relative centrifugal force) with respect to the force of gravity. The author notes that "centrifugal forces found by use of this nomogram are too high, in most regions by from about 2 to 6 per cent."

STUDIES IN ULTRA-VIOLET AND RESPIRATORY PHENOMENA, I-II. Ann. Missouri Bot. Gard., 22 (1935), No. 4, pp. 771-860, figs. 13. The following three sections are included here:

I. *Review of work published before June 1935,* F. L. Wynd and E. S. Reynolds (pp. 771-835). The subject matter is discussed under basal metabolism of animals, metabolism of plants, oxidizing enzymes, and sulphydryl compounds, and from this review it is concluded that ultraviolet light has a general destructive effect on oxidizing enzymes in vitro, with the exception of xanthine oxidase. The three classes—invertase, catalese, and rennet—are recognized, but the exact nature of their differences is considered still unknown. The various degrees of injury reported by different workers are not to be considered as inconsistent, since there are many complex factors operating to give the final effect. This is particularly true of studies in vivo. It is not deemed possible at present to analyze the effect of ultraviolet light on respirational metabolism into its various components. An 8-page bibliography is appended.

II. *The effects of ultra-violet on respiration and respiratory enzymes of higher plants.* F. L. Wynd, H. J. Fuller, and E. S. Reynolds (pp. 837-852). In tomato plants exposed to a mercury arc under various conditions injurious irradiation stimulated respiration and peroxidase, oxygenase was inhibited, and catalase reacted variously but, in general, was stimulated. The most pronounced effect of noninjurious irradiation was a great stimulation of the catalase.

In bean plants comparatively weak doses induced chiefly a greatly stimulated peroxidase. These plants failed to exhibit oxygenase activity, indicating a different chemical physiology consistent with their different reactions to irradiation.

"The comparative activities of peroxidase and oxygenase show that the oxygenase-peroxide-peroxidase system . . . does not represent a fundamental respiratory mechanism in the tomato plant."

III. *The influence of various regions of the spectrum on the anaerobic fermentation of yeast.* E. S. Reynolds and F. L. Wynd (pp. 853-860). The data obtained indicated that ultravoilet light between 3,000 and 2,500 angstrom units has an inhibiting effect on the fermentative activity of suspensions of 2-hour cultures of baker's yeast in Pasteur medium. This is a specific effect not depending on a general injury to the cell. The degree of inhibition is both a qualitative and a quantitative function of the ultraviolet light. Irradiations of longer wavelength than 3,000 Angstrom units were without effect.

INFLUENCE OF TEMPERATURE ON RESPIRATION OF COWS, *M. Kleiber* and *W. Regan.* Soc. Expt. Biol. and Med. Proc., 33 (1935), No. 1, pp. 10-14, fig. 1. Studies at the California Experiment Station showed that an increase in environmental temperature above 10 degrees (Centigrade) increased the respiratory frequency of two cows according to the Arrhenius equation with a temperature characteristic of 12,000 and 13,000 calories, respectively. Cooling inspired air in a hot environment decreased the respiratory frequency and the rate of ventilation and increased the depth of breathing. In a cold environment heating the inspired air did not significantly affect respiration. Shallow breathing at high frequency with increased dead space per breath enabled the animals to combine a large total ventilation and evaporation of water with a relatively small alveolar ventilation.

A SIMPLE METHOD OF HEAD THRESHING, *F. H. Peto.* Sci. Agr., 15 (1935), No. 12, pp. 825, 826, fig. 1. A simple device for threshing single spikes or panicles of cereals and grasses is described. *(Continued on page 536)*

Agricultural Engineering Digest

(Continued from page 534)

THE USE OF ARTIFICIAL LIGHT AND REDUCTION OF THE DAYLIGHT PERIOD FOR FLOWERING PLANTS IN THE GREENHOUSE, *G. H. Poesch* and *A. Laurie.* Ohio Sta. Bul. 559 (1935), pp. 43, figs. 8. Further studies again gave evidence that the time of flowering of greenhouse plants can in many species be profoundly influenced by modifications in the length of the day. Finding that with chrysanthemums satisfactory results were secured when the day was shortened either at the beginning or end, the author suggests that dark cloth may thus be used to advantage on two beds each day. With asters, the late-flowering varieties showed a greater response to shading than did early varieties. In general the shading of asters should begin about 8 weeks after planting. Bulbous plants, with the exception of *Lilium longiflorium* and *Iris tingitana,* showed little or no response to increased day length. Among annuals to show a striking earliness in bloom when given supplemental light were snapdragons, stocks, feverfew, *Coreopsis tinctoria, Centaurea cyanus, Gypsophila elegans,* and *Salpiglossis sinuata.* Additional light during cloudy weather failed to yield results commensurate with the increased cost.

A comparison of neon, mercury vapor, and Mazda lamps showed decidedly in favor of Mazda light, the flower stems being longer in every instance and more flowers being produced in all but one variety. Low-wattage lamps (25 to 40) with intensities of from 1.5 to 44 foot-candles were equally as effective as higher wattage and more costly lights.

Comparing clear and frosted lamps, it was noted that stem length was the only character influenced, being slightly longer under clear light.

Practical considerations involved in the supplemental lighting of greenhouses are also discussed by L. C. Porter of the General Electric Research Laboratories of Cleveland.

OSRAM AND NEON LIGHTS IN VEGETABLE FORCING [trans. title], *J. Reinhold.* Gartenbauwissenschaft, 9 (1935), No. 6, pp. 558-574, figs. 12. In most cases additional light supplied by either type of lamp produced larger crops and induced earlier fruiting. In most instances neon light proved superior to osram light, but the tomato was somewhat sensitive to neon and did better with the osram light. Of three crops, cucumbers, tomatoes, and kohlrabi, only the cucumber returned sufficient profit from supplemental light to justify its use.

COLORIMETRIC DETERMINATION OF SMALL QUANTITIES OF CHLORIDES IN WATERS IN WATERS, *H. B. Riffenburg.* Indus. and Engin. Chem., Analyt. Ed., 7 (1935), No. 1, p. 14. The author modifies the titration with silver nitrate solution in the presence of potassium chromate as the indicator to the extent of adding the indicator solution to each of two Nessler tubes of the water to be examined and adding the silver solution, drop by drop, with frequent comparison with the tube containing only the sample and indicator solution. He advises that the silver nitrate solution should not be stronger than the equivalent of 0.05 mg per cubic centimeter, but "should not be too weak."

SOIL MOISTURE AND IRRIGATION INVESTIGATIONS IN EASTERN APPLE ORCHARDS, *J. R. Magness, E. S. Degman,* and *J. R. Furr.* U. S. Dept. Agr., Tech. Bul. 491 (1935), pp. 36, figs. 12. During the four seasons 1930-33, in which the relation of soil moisture conditions to tree response was studied in irrigated and non-irrigated plats in apple orchards in western Maryland, there was noted at some time during each season reduced fruit growth rate due to a shortage of soil moisture, despite the fact that in three of the years the total rainfall from May 1 to October 31 was above normal. Under favorable conditions the growth of apple fruits measured on a volume basis proceeded at very nearly a uniform rate from a period some 6 to 8 weeks following bloom until near harvest time. In most cases the growth rate of fruit of trees growing in moderate-textured silt loam or silt clay soils was not measurably reduced until at least the driest part of the root zone approached the wilting percentage. In the case of moderate droughts causing no serious loss of foliage, growth of fruit was resumed at an apparently normal rate upon the restoration of moisture, but the ultimate size of the apples was reduced in proportion to the length and duration of the droughts.

WINTER HOUSING FOR LAYERS, *D. C. Kennard* and *V. D. Chamberlin.* Ohio Sta. Bimo. Bul. 177 (1935), pp. 190-196, fig. 1. This article discusses some of the fundamental principles of temperature, ventilation, and dampness control, and their practical application to the winter housing of poultry flocks.

COMPARISON OF ELECTRIC AND COAL BROODERS IN EARLY SEASON BROODING, *J. A. Davidson* and *H. J. Gallagher.* Michigan Sta. Quart. Bul., 18 (1935), No. 2, pp. 97-105, figs. 3. Results of two tests showed that the rate of feathering of broilers was slower under electric hovers than under coal hovers. With the type of ventilation used, insulation was not justified from the standpoint of fuel consumption. A fan or air agitator on one of the electric hovers did not materially increase the amount of power used, but was helpful in the early brooding period when the hover was down.

TRACTOR VERSUS HORSE AS A SOURCE OF FARM POWER. *N. Jasny.* Amer. Econ. Rev., 25 (1935), No. 4, pp. 708-723, figs. 3. The items of cost in horse and tractor work the proportion of fixed and variable charges, the amounts of labor required, and the indirect effects of the wage level are discussed. The conditions favorable and unfavorable to tractor utilization in different agricultural districts of the United States and in Canada, Argentina, Australia, and different European countries are briefly summarized.

The annual work per horse is a more important factor than the relation of costs of horses and feed to costs of tractors and fuel. The saving on labor with tractors is less important than the variation in the annual amount of work per horse. The same is true for other factors affecting the variation in the use of tractors, i.e., size of farms, seasonal distribution of power and labor requirements skill of tractor operators, topography, soils, etc.

WIND DATA FOR WIND MILLS, *V. Doraiswamy Iyer.* India Met. Dept. Sci. Notes, 6 (1935), No. 63, pp. 57-85, pls. 7; abs. in Sci. Abs., Sect. A—Phys., 38 (1935), No. 452, p. 811. "Monthly normals of wind velocity for 205 observatories in India and a few stations in the neighboring countries are given, and the distribution of wind velocities in the different seasons is illustrated by charts. Curves of the diurnal variation of wind velocity at 22 stations for the four seasons are given. Tables giving the frequencies of occurrence of winds of different speed ranges and of days with different total duration of wind speeds exceeding 6 miles per hour, which is considered the minimum for working a windmill for agricultural purposes, have also been prepared for 15 stations. The data presented are briefly discussed."

The results of the study confirm the conclusion that over the greater part of India, including all of northern India, the energy of the wind is of no practical value, but that there are many places in Peninsular India where it might be profitable to make use of windmills for irrigation.

THE IMPORTANCE OF THE VEGETATION FACTOR IN WATER CONSERVATION AND EROSION CONTROL, *R. V. Allison,* Amer. Soil Survey Assoc. Bul. 16 (1935), pp. 119-122. According to a discussion contributed from the USDA Bureau of Chemistry and Soils, "it appears that erosion control methods are possible . . . for practically any reasonable situation, and that good progress is being made in working out a great number of these; also that there is a steadily increasing appreciation of the value of vegetation in one way or another in the varied programs that are being set up for this purpose." The author feels, however, that "our most, difficult problem in the entire field of soil and water conservation lies in the essential inertia and indifference of the individuals concerned; also that this indifference is largely grounded in the antiquated ideas of land ownership that prevail at the present time—ownership rights that apparently permit a man to completely incapacitate or even entirely destory the soil on his farm in 5, 10, or 20 years by the sheer crudeness of his methods of handling."

TREES AND EROSION CONTROL, *A. C. McIntyre,* Amer| Soil Survey Assoc. Bul.16 (1935), pp. 110-114. This discussion is based, in part, upon experimental work carried out cooperatively by the Pennsylvania Experiment Station and the Soil Erosion Service, U. S. Department of the Interior. In indicating the nature of the work undertaken and of the information thus far secured, the author points out that "vegetation, whether tree, shrub, weed, or grass, functions in four ways to impede soil movement. The aerial parts, the litter, and the roots act mechanically. In addition, the influence that a particular species has on its associated species may control their vegetative density. In an attempt to obtain data on these mechanical and biotic factors, a series of studies was begun, the results of which give comparative values to a number of the more important forest trees for erosion plantings." In considering the choice of species for erosion control plantings, he notes that "taprooted species are difficult to handle. Most hardwoods develop taproots and with few exceptions do not establish themselves as readily as conifers. Mixed plantings are desirable, for many reasons. Extreme losses due to insects or disease are not as likely to occur. The future value of the planting in terms of forest products is increased."

(Continued on page 538)

Agricultural Engineering Digest

(Continued from page 536)

SOIL EROSION AND SOIL RUIN IN SOUTH DAKOTA, *J. G. Hutton.* Amer. Soil Survey Assoc. Bul. 16 (1935), p. 123. It is considered that the "rapid decrease of organic matter in the soil, due to continued cultivation and the return of little or no organic matter to the soil favoring decoherence of the particles in the soil granules," has been an important factor in producing soil conditions favorable for soil drifting. "The low assimilative coefficient of the soils of South Dakota, due to long cold winters when most microbiological processes are suspended, the dry seasons when there is not sufficient water to enable the bacteria of decomposition to function, and the very high surface temperatures during midday or midsummer," all contribute slowness of decomposition, so that even under natural conditions the accumulation of soil organic matter is slow. It is considered a conservative estimate that during the 50 years the soils have been under cultivation as much organic matter has disappeared as accumulated during the previous 5,000 years.

"This long-time depletion of organic matter, together with the prolonged drought which destroyed or prevented the growth of a vegetative covering and made overgrazing a necessity, together with the fact that the moisture films on the soil particles have been so thin for many months, all have favored the movement of soil by the wind. Several violent windstorms, usually related to the wind-shift line of passing areas of low pressure, as on November 12, 1933, March 16, 1934, May 9, 1934, and several other notable gales, started soil moving so that more moderate winds could continue the process. These factors, together with the level topography of the terrain, have contributed to the serious soil condition in South Dakota."

MOISTURE CONSERVATION IN RELATION TO EROSION CONTROL UNDER RED PLAINS CONDITIONS IN THE SOUTHWEST, *H. G. Lewis.* Amer. Soil Survey Assoc. Bul. 16 (1935), pp. 124-126. A brief article from the USDA Oklahoma Soil Erosion Experiment Station cites various observations supporting the opinion that in many cases "moisture is the limiting factor in crop production in the Red Plains region, and, as during the early spring and fall months there is a surplus amount of moisture, it behooves us to control this surplus so that there will be a plentiful supply of moisture in the soil during the hot dry summer period. Incorporation of organic matter into the soil changes the structure and aids water-holding capacity. A good crop rotation, in conjunction with winter cover crops and leguminous crops, should be used, which not only builds up the fertility of the soil but also helps check run-off and soil losses."

THE EXTENT TO WHICH THE EROSIBILITY OF A SOIL CAN BE ANTICIPATED BY LABORATORY PHYSICAL AND CHEMICAL MEASUREMENTS, *H. E. Middleton* and *C. S. Slater.* Amer. Soil Survey Assoc. Bul. 16 (1935) pp. 128-130. With respect to the possibility of calculating from available data a value approximately representative of the relative erosibility of a soil, the authors of this contribution from the Soil Erosion Service state, in part, that "the erosion ratio involves four separate laboratory determinations and may be written as the product of two other ratios.

$$\text{Erosion ratio} = 100 \times \frac{\text{suspension percentage}}{\text{total percentage silt, clay}} \times \frac{\text{moisture equivalent}}{\text{colloid percentage}}$$

where the term suspension percentage is the percentage of the soil (silt and clay) which remains suspended in water under standard conditions, total percentage of silt and clay is the amount of these materials found by mechanical analysis, moisture equivalent the usual determination at 1,000 gravity, and colloid percentage is the percentage of colloid determined by the moisture absorption method. Either of the contributing ratios of the erosion ratio may be considered as a partial measure of the erosibility of soils. The amount of silt and clay which readily remains suspended in water obviously measures an erosive tendency. In soils of fine texture this factor of the ratio is paramount. However, observation and opinion have indicated that the suspension percentage alone does not give a figure sufficiently high to represent the erosibility of sandy soils. Multiplication by 100/total percentage silt and clay, was accepted as a purely arbitrary method of modifying the suspension percentage to agree with known erosibility. It is to be noted that this modification would have no effect on the ratio for a soil 100 per cent silt and clay."

IRRIGATION EXPERIMENTS WITH WHEAT. *A. T. Bartel* and *C. Hobart.* Arizona Sta. Bul. 151 (1935), pp. 355-388, figs. 14. Experiments involving 10 irrigation treatments were conducted in cooperation with the U. S. Department of Agriculture with Baart wheat at the Salt River Valley Experiment Farm at Mesa, where because of mild winters, spring wheat is planted in December or January. Two treatments totaled 12 inches of water each, seven 18 inches, and one treatment 27 inches, variously applied before and after planting, in the tillering, jointing, heading, and soft- and hard-dough stages.

The stand was reduced greatly by irrigation as soon as the wheat was planted. Irrigation at the tillering stage was not economical from the viewpoint of soil moisture. Plants receiving no irrigation between tillering and heading usually lodged severely when the irrigation at heading was applied, apparently due to poor crown-root development.

The irrigation procedure before heading resulted in more tillers per plant where the applications of water were small, a higher percentage of head-producing tillers and more heads per plant where the total amount of water applied before heading was small, and more heads per unit area of land as the total water applied before heading decreased. The last three characters correlated very highly with grain yields. Single applications exceeding 3 inches before heading caused the plants to assume an unhealthy yellow appearance, probably due to leaching of nitrates into the subsoil and to insufficient soil aeration.

Applications of but 3 inches of water at the heading and soft-dough stages did not keep the moisture above the wilting coefficient in the third foot of soil. Six-inch applications are recommended at these two stages. Irrigation at the hard-dough stage is not advised because it leaves some soil moisture above the wilting coefficient when the plants reach maturity.

The average weight of 100 kernels at maturity rose with the total irrigation after jointing until a total of 15 inches of water had been applied. The highest yields of grain and straw were obtained from use of 3 inches of water before planting, 3 at jointing, 6 at heading, and 6 inches at the soft-dough stage. This treatment was most satisfactory in producing plant characters correlated with yield, and also supplied enough moisture after heading to insure good, large, plump kernels.

A MECHANICAL INSECT TRAP. *C. B. Williams* and *P. S. Milne,* Bul. Ent. Res., 26 (1935), No. 4, pp. 543-551, pl. 1, figs. 2. A description is given of an electro-mechanical insect trap developed at the Rothamsted Experimental Station. This trap consists essentially of two long conical muslin nets fastened to the ends of a light framework, about 12 ft. in diameter, which is free to rotate and which can be raised and lowered so that the distance of the nets from the ground can be altered. In the mouth of each net is an electric fan which drives a rapid current of air into the net and at the same time pulls the net forward so that the whole framework rotates horizontally round the central axis.

INFLUENCE OF FOREST LITTER ON SURFACE RUN-OFF AND SOIL EROSION. *H. G. Meginnis.* Amer. Soil Survey Assoc. Bul. 16 (1935), pp. 115-118, fig. 1. A communication from the USDA Southern Forest Experiment Station reports, in part, that: "Forest litter contributes greatly to ground storage of rainfall, even when the underlying soil was previously in an extremely compacted and unabsorptive condition." The addition of forest litter reduced erosion to a negligible quantity and decreased surface run-off from 1 year's precipitation by more than half.

"The results of this study emphasize the importance in reforesting similar eroded soils, of such procedure as close spacing of trees, the use of herbaceous cover crops, and the employment of cultural or protective treatment that will make for the most rapid production and maintenance of a litter cover."

SOIL SWELLING.—1. THE SWELLING OF SOIL IN WATER CONSIDERED IN CONNECTION WITH THE PROBLEM OF SOIL STRUCTURE. *D. T. Sideri,* Soil Sci., 41 (1936), No. 2, pp. 135-151, fig. 1. The author considers that a study of the swelling of soil in natural structural condition "allows investigation of the problem of soil structure from a new point of view." He presents a method, derives a form for a quantitative expression of the porosity changes caused by absorption of water by soil, and introduces definitions of the "index of texture stability" (*S*) and of "swelling water" (*Wq*), founded on the sharp difference between capillary imbibition and swelling proper.

"Swelling water may be considered as the form of expressing the hydrophilic property of soil. Soil swelling is considered as a process of changes arising in the properties of soil at the interface soil colloids/water. This process leads to a change in the structure of soil and to an increase in its degree of dispersion. A quantitative expression of this process is possible in the form of swelling water, which represents a more characteristic indicator of swelling than the increase of volume."

A method for a differential analysis of soil porosity, providing for its subdivision into noncapillary, capillary, and submicroscopic porosity, is proposed. *(Continued on page 540)*

Agricultural Engineering Digest

(Continued from page 538)

A Water-power Mechanical Insect Trap. *W. M. Davis*, Bul. Ent. Res., 26 (1935), No. 4, pp. 553-557, pl. 1, figs. 3. An illustrated description is given of a mechanical insect trap based upon that perfected by Williams and Milne, previously noted and adapted to be driven by water power.

The Times of Activity of Certain Nocturnal Insects, Chiefly Lepidoptera, as Indicated by a Light-trap. *C. B. Williams*, Roy. Ent. Soc. London, Trans., 83 (1935), No. 4, pp. 523-555, pls. 2, figs. 9. A description is given of a light trap which has under it eight killing bottles arranged so that by a clockwork mechanism they can be changed at any time desired during the night. The trap was working in the fields at Rothamsted Experimental Station on all except 17 nights in the 2 years from March 1, 1933, to Feb. 28, 1935, some 109,344 insects having been captured the first year and 103,362 the second.

The Optimum Temperature for Electric Water Heaters. *E. H. Roberts*, Washington Sta. Bul. 325 (1935), p. 43. This progress report summarizes data obtained from manufacturers in the Pacific Northwest on temperature control.

Refrigeration of Oranges in Transit from California. *C. W. Mann and W. C. Cooper*, U. S. Dept. Agr., Tech. Bul. 505 (1936), pp. 88, figs. 36. Based on the results of 29 refrigeration tests made during the period 1928-33 with cars iced according to different plans, the authors report that during the summer months preicing of the cars before loading followed by reicing at the first icing station and once again in transit afforded nonprecooled fruit better temperatures than did standard refrigeration, which consisted of icing after loading and at every regular icing station enroute. Preiced cars not replenished at the first icing station but iced once in transit gave refrigeration equal to standard refrigeration in the fall but not in summer. Preiced cars replenished by the shipper at the packing house and reiced once in transit gave better refrigeration than standard refrigeration during summer, provided the cars were held at the packing house from 12 to 24 hours, after loading before replenishing the bunkers. Preiced cars replenished after loading and not reiced in transit gave nonprecooled fruit temperatures equal to standard refrigeration during early spring and late fall. Precooling fruit in the car with fans for 16 hours increased materially the rate of cooling, especially in the top layer, and decreased temperature differences throughout the load. The lowest and most uniform temperature in the tests occurred in carloads of warehouse-precooled fruit preiced only. No significant relation was recorded between method of refrigeration and spoilage, very little loss occurring in any of the shipments. Loss in weight of fruit in transit was slight and was determined largely by the temperature of the fruit.

Technical information is presented on the sources of heat to fruit in transit, effect of outside temperatures, effect of fruit temperature at loading on the refrigeration of oranges in transit, and the effect of the manner of loading on the temperature of the fruit in the car.

The granting of lower rates on the various modified types of refrigeration is said to have led to the adoption of the modified methods in place of the more costly standard refrigeration.

Orchard Heating. *A. H. Hoare*. Jour. Min. Agr. [Gt. Brit.], 42 (1936), No. 12, pp. 1218-1220, pl. 1. Attention is called to tests of a liquid fuel burner, devised by a practical orchardist, which appears to be capable, when used at the rate of 50 heaters per acre properly distributed, of maintaining the air temperatures of orchards above the danger point. "This heater consists of a metal canister having a flame hole, covered by a lid, in the top, and 6 airholes in the side separated by a quarter of the circumference. The wicks are made of asbestos rope so that they can be used throughout the season without renewal by simply resoaking them in fuel oil when the latter is renewed. The heaters are designed to burn crude oil. . . . The heaters are now designed to burn for a period of 11-12 hours. The fuel capacity is 3 gallons. . . . The conclusions to be drawn after the tests of the system provided by the severe frosts of May 1935 are that orchard heating is practicable provided the organization is good, the number of heaters to the acre is not below the minimum laid down, and that there is little or no wind."

Effect of Narrow Ranges of Wave-length of Radiant Energy and Other Factors on the Reproductive Growth of Long-day and Short-day Plants. *N. A. Schappelle*. [New York] Cornell Sta. Mem. 185 (1936), pp. 33, figs. 17. Red and blue lights were about equally effective in inducing the reproductive growth response in radish, spinach, *Crepis*, and *Marchantia*. Blue light was superior to red in causing flowering in lettuce, probably due to the better effect of blue light on the plant as a whole. The red light stimulated flowering, but the plants were too weak to complete the flower development. Infrared was ineffective for inducing fruiting in *Marchantia*. When the intensity of natural light during winter was increased (especially with the use of red or blue light), normally long-day plants such as radish or *Marchantia* could be forced into fruiting in a 10-hour day. At low light intensities the fruiting response in *Marchantia* was proportional to the increase in intensity.

Temperatures of from 10 to 20 (Centigrade) tended to aid the initiation of reproductive growth in the plants tested, but more vigorous vegetative growth occurred at from 25 to 30 degrees.

Mineral nutrients (especially nitrates) tended to delay reproductive growth in the plants used, but when they made the plant more vigorous the total flowering response, if initiated by proper light treatment, eventually became greater.

Aster and early flowering cosmos, though short-day plants, were not extremely sensitive to the photoperiod and flowered even in a long day if the light intensity was not too great. Red light proved superior to blue for flowering in such plants regardless of length of exposure, but blue light did not completely inhibit flowering. *Salvia, Chrysanthemum, Kalanchoe,* Maryland Broadleaf tobacco, and teosinte were extremely sensitive to the photoperiod, not flowering at any of the long-day exposures. Five hours of daylight immediately followed by 5 hours of red light or 10 hours of daylight daily induced a good flowering response in these plants, but a short day of 5 hours of daylight and 5 hours of blue light almost completely inhibited flowering.

Short-day plants are probably prevented from flowering in summer both because of the long photoperiod and because of the high intensity of the blue light. On the other hand, long-day plants fail to flower in winter both because of the short photoperiod and because of the low light intensity, especially of the blue light.

Either end of the spectrum, when given in the complete absence of the other, caused abnormal growth and injury. In this respect blue light seemed to be more injurious than the red for all plants tested except lettuce.

The methods used for the physical measurements and for the culture of the plants are described in detail.

Exposure Test on Repainting Wood Surfaces. *Oil, Paint, and Drug Reporter*. 128 (1935), No. 22, pp. 58-60, figs. 4. Repainting tests on fences painted in 1931, conducted by the USDA Forest Service in cooperation with several private commercial paint agencies, are reported. The tests were started in 1935 and only preliminary results were available.

Very definite differences in the characteristics of the old coatings of white lead, lead-and-zinc, and titanox-and-zinc paints were observable during the application of the first coats of new paint.

The old coating of white lead paint on the south side of the fence was much softer than either of the other two paints and for that reason had to be sandpapered very lightly to keep from removing the old coating entirely. On the north side of the fence the white lead paint was harder than it was on the south side, but was softer than the other two paints on the north side. These differences in hardness were paralleled closely by differences in absorptiveness for the new paint or for the oil of the new paint. On the south side of the test fence the painters could feel the greater suction of the old white lead paint very distinctly as they brushed on the new paint. On the north side there was much less difference between the paints in this respect.

After the first coats of new paint were dry the differences in absorptiveness of the old coatings were reflected in the degree of gloss of the new ones. On the south side of the fence all first coats of paint dried without gloss over old white lead paint, except where aluminum priming paint had been used under the white lead paint. The attempts to repaint the white lead paint with one coat instead of two coats were not satisfactory on the south side for this reason. Over the old lead-and-zinc and titanox-and-zinc paints on the south side the first repaint coats dried with a good uniform gloss. Where aluminum priming paint had been used the gloss was observably greater than elsewhere. The one-coat repaint jobs over the harder paints were satisfactory from the point of view of hiding power and uniform gloss.

Bibliography on Natural and Pozzolanic Blended Cements and Related Subjects. *S. P. Wing*. U. S. Bur. Reclam., 1934, pp. 63. This working bibliography has been compiled for the purpose of investigating the possibilities of either decreasing the cost or improving the qualities of standard portland cement used in hydraulic structures by blending it with pozzolanic materials.

About 400 references are included. (Continued on page 542)

Agricultural Engineering Digest

(Continued from page 540)

MOTORIZATION OF DRAFT WORK OF NORWEGIAN AGRICULTURE. [*trans. title*]. *A. Berdal.* Meld. Norges Landbr. Heiskole, 15 (1935), No. 7-8, pp. 559-731, figs. 31. A technical study of power farming in Norway is presented, the purpose being to provide the basis for economical motorization of the draft operations. Special attention was given in the study to the comparative economies of horsepower and tractor power, with full consideration for the local conditions of topography, soil, and prevailing agricultural practices.

The conclusion is that the economical use of tractors is practically impossible in the valley, mountain, and fiord regions of Norway on account of the topography and size of farms. The best conditions for tractor use are found in the regions where loam soils predominate.

DESIGN OF CONCRETE STRUCTURES. *L. C. Urquhart* and *C. E. O'Rourke.* New York and London: McGraw-Hill Book Co., 1935, 3. ed., IX + 556, figs. 255. This is the third edition of this book in which most of the material has been rewritten to include the latest and best practice in plain and reinforced concrete design.

Modern methods of design and control of concrete mixtures are described in detail. In the development of the elementary design theory the principle of the transformed section has been used in addition to the usual design formulas. The chapter on the continuous frame has been rewritten to show more clearly the interrelation of the moments in the intersecting and adjacent members. Additional material has been added to the chapter on footings, including designs of typical multiple-column footings and the method of proportioning footings for uniform settlement. The chapter on buildings has been expanded to include a larger variety of types of floor construction, particularly those for the lighter loadings. Complete designs are given for all types. In the chapter on highway bridges complete designs of the various types of concrete bridges have been included, and essential construction details of these structures have been given.

Tables and diagrams have been expanded for use with the higher strength concretes of the present day.

NITRIFYING BACTERIA IN WATER SUPPLIES. *D. Feben,* W. Va. Univ. Bul., 35 ser., No. 4 (1934), pp. 13-23. Studies are reported the results of which indicate that Great Lakes water (and presumably all surface waters) definitely contain nitrifying bacteria of an undetermined species. Artificial methods of culture are simple and direct. Sand filtration after ammoniation promotes their growth during suitable water temperatures to a point where the chloramine process defeats its own purpose and becomes costly, due to wasting of both ammonia to feed the bacteria and chlorine to oxidize their products. Their resistance makes it appear impossible or impractical to control nitrification by chlorination.

THE LONGITUDINAL VARIATION OF TIMBER DURING SEASONING. *M. B. Welch,* Roy. Soc. N. S. Wales, Jour. and Proc., 68 (1934), pp. 249-254. An examination is reported of the longitudinal variation of some 300 samples of a large number of different woods in relation to their densities. It was found that, while 66 per cent of the total samples swelled or remained stationary during drying from a green condition to the fiber saturation point, only 33 per cent behaved similarly from the fiber saturation point to an air-dry condition. In general, woods of low density showed the greatest tendency to swell, and heavy woods were more prone to remain stationary during the initial drying period. Below the fiber saturation point light timbers showed the greatest liability to shrinkage, and heavy woods were inclined to remain stationary or to swell. In a number of timbers the longitudinal movements were irregular, expansion and contraction occurring several times during seasoning—an indication that length is not always a function of the moisture content of the wood.

It is suggested that severe internal compressive stresses resulting from the shrinkage of the outer part of the wood may be responsible for the elongation or longitudinal swelling during seasoning.

DRIER AIR FOR SUMMER COMFORT. *V. L. Sherman,* Amer. Builder and Bldg. Age, 57 (1935), No. 8, pp. 34-36, figs. 4. In a contribution from Lewis Institute of Technology, Chicago, Ill., air conditioning equipment for homes is briefly described and illustrated.

RELATION OF RAINFALL TO FLOOD RUN-OFF. *C. R. Pettis.* Mil. Engin., 28 (1936), No. 158, pp. 94-98. figs. 2. In this paper the relation of rainfall to flood run-off is reduced to a simple mathematical basis.

A PROGRESS REPORT ON THE INVESTIGATION OF THE VARIOUS USES OF ELECTRICITY ON THE FARMS OF WASHINGTON FOR THE YEAR OF 1935. *L. J. Smith* and *H. L. Garver.* Wash. Com. Relat. Elect. Agr., 1936, pp. 23, pls. 5. Included in this report are the progress results of experiments on the development of a vegetable washer, pasture irrigation, heating of bait traps for codling moth control, and fruit and vegetable processing.

SEWAGE SEDIMENTATION AND SOIL PURIFICATION IN THE TROPICS (trans. title). *C. P. Mom* and *N. D. R. Schaafsma, Meded.* Dienst Volksgezondh, Nederland, Indie, 22 (1933), No. 3, pp. 161-181, figs. 7. In investigations conducted in the Dutch East Indies, observations were made of the soil in the vicinity of septic tanks.

Specimens of soil obtained from borings showed the presence of fecal bacteria to a depth of 10 meters (32.8 feet). It also was found that the destruction of the fecal bacteria is very slow in soil.

BACTERIUM COLI introduced into the ground at a distance of 50 meters (164 feet) from sources of water supply were demonstrated in the water after 37 days.

HEATING AND AIR CONDITIONING. *J. R. Allen* and *J. H. Walker.* McGraw-Hill Book Co., 1935, 4, ed., pp. VII + 444, figs. 242. This is the fourth edition of this book formerly entitled Heating and Ventilation. It contains chapters on heat and the properties of steam; heat losses from buildings; methods of heating; warm-air furnace heating; radiators; fuels and boilers; steam heating systems; pipe, fittings, valves, and accessories; steam piping; temperature control; central and district heating—electric heating; air and its properties; principles of air conditioning; ventilating and air-conditioning systems; design of central fan systems; unit systems; filters, washers, and humidifiers; artificial cooling; industrial air conditioning; and a chapter on hot-water heating systems, by F. E. Giesecke.

THE "CHATHAM HEATER" FOR THE SMALL SASH HOUSE. *J. G. Wells, Jr.* Michigan Sta. Quart. Bul., 18 (1936), No. 3, pp. 148-151, figs. 3. A heater for the small sash greenhouse is described and illustrated, the principle of which is that of using heat retained in heated stones.

The Chatham heater consists of an oil drum surrounded by stones. A comparison of this heater with other types for poultry houses showed that the same stove rocked in held more even temperatures and required less fuel than those not covered. A coal heater used in the laying houses in comparison to a wood heater proved just as efficient in heating the house. By burning low-priced splint coal, fuel cost was found lower than when figuring the retail price of wood. It is believed that any coal-burning heater can be covered with stone and used in the sash house with as good results as the wood burner tried. Care should be taken in that case that the flue is built so that wind will not blow down the chimney and fill the plant house with coal gas. The Chatham heater used in the poultry plant was made of stone set in mortar.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE IOWA STATION. *J. B. Davidson, E. V. Collins, W. G. Murray, C. K. Shedd, H. Giese, P. E. Brown, A. A. Bryan, H. R. Meldrum, A. J. Engleborn, R. E. Bennett, Q. C. Ayres, H. D. Hughes, F. B. Smith, G. W. Musgrave,* and *G. B. MacDonald.* Iowa Sta. Rpt. 1935, pp. 35-42, 148-152, figs. 6. The progress results are briefly presented of investigations of mechanical corn production methods, farm building losses due to wind and fire, all-masonry barns, use of tractors, tractor track efficiency, development of equipment for checkrowing beets, new type of terracing machine, accuracy of four-row corn checkrowers, wagon and trailer hitches, efficiency of corn pickers, seedbed preparation for corn, weed control in growing corn, influence of tractor drivewheel diameter on tractive efficiency, terrace construction methods and costs, utilization of clay products in farm building construction, and soil erosion on Marshall silt loam.

HOW TO BUILD A WIND-PROOF GOTHIC BARN. *A. W. Holt,* Amer. Builder and Bldg. Age. 57 (1935), No. 8, pp. 46-49, 71. figs. 5. Structural details are presented and discussed.

DESIGN OF EARTH FILL DAMS. *W. W. Wyckoff.* Jour. Amer. Water Works Assoc., 28 (1936), No. 1, pp. 127-133, figs. 4. Basic principles of design are enumerated and discussed, these relating primarily to structural stability and imperviousness.

Improving Drain Tile Resistance to Alkali Conditions

(Continued from page 515)

though, clearly indicate it has enough merit, when used in conjunction with steam curing at temperatures between 100 and 155 deg, to justify its use, at least for moderately severe exposure conditions.

CONCLUSIONS

Under identical exposure conditions, concrete made of a highly resistant portland cement may last ten times as long as that made of a cement of low resistance. With portland cements differing so greatly in resistance to sulphate action, certainly the first consideration for all concrete that is to be so subjected should be the cement itself, and, regardless of all other precautions, the use of a cement of low resistance should be avoided. Until a more accelerated test of equal reliability is developed, the 16-week test as outlined herein is recommended.

Resistance of concrete is markedly increased by curing in water vapor at temperatures of 212 to 350 deg, almost to the point of immunity for the most favorable temperatures and curing periods. Resistance is not increased, however, by raising the curing temperatures until 212 deg is reached, except in connection with certain admixtures.

Apparently about equal resistance is secured by curing for the time periods and temperatures as follows: 212 deg for 8 days, 230 deg for 4 days, 260 deg for 2 days, 285 deg for 1 day, 315 deg for 12 hours, and 350 deg for 6 hours.

Calcium chloride used as admixture in concrete cured in water vapor at temperatures between 100 and 155 deg appreciably increases resistance, but check tests are too limited as yet to justify specific recommendations.

Finally, regardless of all other factors, care should be observed in all particulars to obtain the highest practicable 28-day strength with any given cement and any predetermined condition of curing. Strength, although fallible for comparing different concretes, has much value as an index of the permeability and sulphate resistance of the products made of the same cement and by the same methods of manufacture. This is particularly true where rich mixes are used as is the case in the manufacture of high-quality drain tile.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS WANTED

ARCHITECT, with college training and experience in England desires employment where his training and experience will apply. Prepared plans and supervised erection of large housing scheme in England. Following World War service in which he served with rank of captain, he became superintendent of construction of three of the largest hotels in Canada. Five year's experience as assistant architect, Central Experimental Farm, Department of Agriculture of Canada. Made intensive study of mechanical and nonmechanical ventilation of barns and other farm buildings. Can furnish best of references. Will go anywhere. Married. PW-274